California Energy Commission

STAFF REPORT

NOTICE OF INTENT TO ADOPT THE PROPOSED NEGATIVE DECLARATION FOR THE CHEMEHUEVI INDIAN TRIBE PROJECT "DEMONSTRATION OF COMMUNITY SCALE GENERATION SYSTEM AT THE CHEMEHUEVI COMMUNITY CENTER"

(EPC-15-003)

Proposed Electric Program Investment Charge (EPIC) Grant

CALIFORNIA
ENERGY COMMISSION

Edmund G. Brown Jr., Governor

SEPTEMBER 2015

CEC-500-2015-067

CALIFORNIA ENERGY COMMISSION

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ABSTRACT

California Energy Commission (Energy Commission) staff proposes that the Energy Commission enter into a $2.6 million Electric Program Investment Charge (EPIC) grant agreement with the Regents of the University of California, Riverside to build a Community Scale Generation System at the Chemehuevi Indian Tribe Community Center. The EPIC Program administered by the Energy Commission provides funding for applied research and development, technology demonstration and deployment, and market facilitation for clean energy technologies and approaches for the benefit of ratepayers of Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company through a competitive grant solicitation process.

Chemehuevi Indian Tribe is a federally recognized Native-American Tribe located in Needles, San Bernardino County, California. The Community Scale Generation System project would be constructed on land that is self-governed by the Chemehuevi Indian Tribe. Chemehuevi Indian Tribe conducted an environmental review according to their Environmental Policy Ordinance 2002.1, which requires a detailed report on the environmental impacts of the proposed action that is in substantial compliance with the requirements set out in the National Environmental Policy Act (NEPA). On July 24, 2015, Chemehuevi Indian Tribe approved their Environmental Assessment (EA) of the proposed project and made a Finding of No Significant Impact (FONSI) based on the information in the EA.

Because the Energy Commission proposes to fund the Community Scale Generation System project, an activity that may cause a direct or indirect physical change in the environment, the Commission must comply with the California Environmental Quality Act (Pub. Resources Code, § 21000 et seq.). Energy Commission staff prepared an Initial Study that evaluates the potential effects to the environment located outside the tribal land. As described in the Initial Study, Energy Commission staff determines that the proposed project could not have a significant effect on the environment. Therefore, staff has prepared and recommends that the Energy Commission adopt a Negative Declaration for this project.

Keywords: Energy Commission, Electric Program Investment Charge, EPIC, Community Scale Generation System , solar photovoltaic (PV), grant, technology, California Environmental Quality Act, CEQA, Negative Declaration, Initial Study, National Environmental Policy Act, NEPA, Environmental Assessment, Finding of No Significant Impact (FONSI), Chemehuevi Indian Tribe

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STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

INITIAL STUDY/NEGATIVE DECLARATION

DEMONSTRATION OF COMMUNITY SCALE GENERATION SYSTEM AT THE CHEMEHUEVI COMMUNITY CENTER EPIC GRANT
AUGUST 2015

PROPOSED NEGATIVE DECLARATION

PROJECT:

Demonstration Project – Chemehuevi Community Center
1975 South Valley Mesa Road
Needles, CA 92363

LEAD AGENCY:

California Energy Commission

AVAILABILITY OF DOCUMENTS:

The Notice of Intent to adopt the proposed Negative Declaration has been posted on site, in three locations at 1975 South Valley Mesa Road, Needles, CA 92363 and off site at the Needles Post Office, 628 3rd Street, Needles, CA 92363, and at the San Bernardino County Clerk, 385 N. Arrowhead Avenue, 2nd Floor, San Bernardino, CA 92415-0130
.
This Energy Commission Initial Study and proposed Negative Declaration are available at the following locations:

- Online, at http://www.energy.ca.gov/research/epic/environmental_review_documents.html
- At the California Energy Commission Library, located at 1516 Ninth Street, Sacramento, California 95814, Monday through Friday, between the hours of 8:30 AM and 4:30 PM
- At the Chemehuevi Community Center, located at 1975 South Valley Mesa Road, Needles (San Bernardino County), California 92363, Monday through Friday, between the hours of 8:30 AM and 4:30 PM

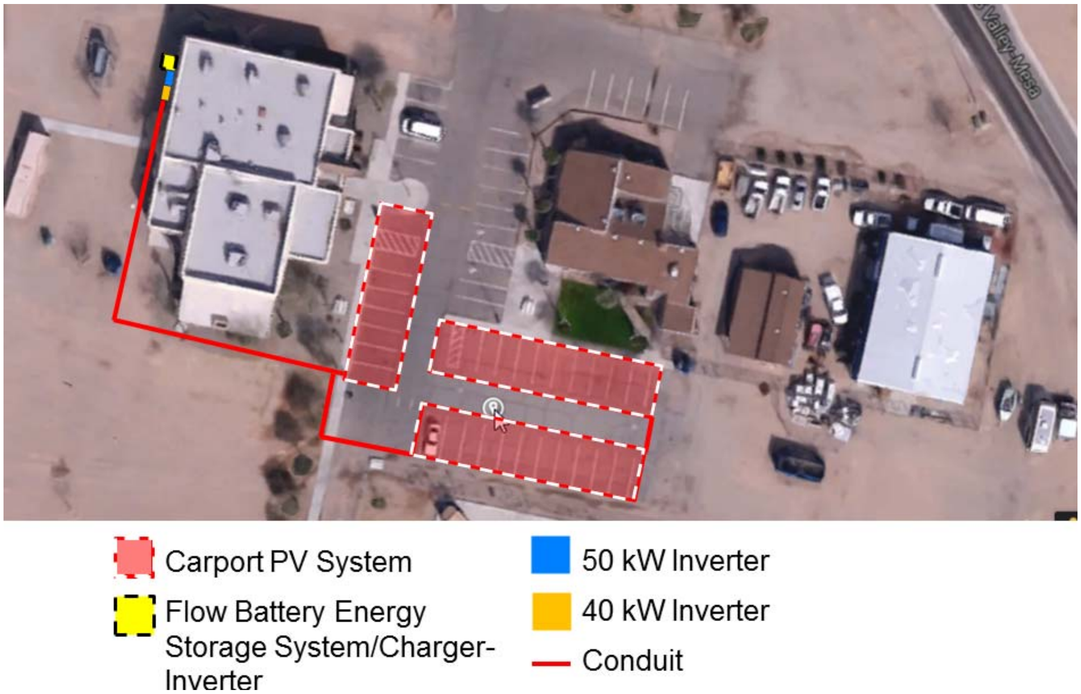
PROJECT DESCRIPTION:

California Energy Commission staff proposes that the Energy Commission enter into a $2,588,906 million Electric Program Investment Charge (EPIC) grant agreement with the Regents of the University of California, Riverside, to build a community scale generation system at the Chemehuevi Indian Tribe Community Center at 1975 South Valley Mesa Road, Needles, CA 92363. The Chemehuevi Indian Tribe is a federally recognized Native-American Tribe located in San

Bernardino County, California. The project would be constructed on land that is self-governed by the Chemehuevi Indian Tribe and is subject to Chemehuevi Indian Tribe’s Tribal Ordinance, including environmental review.

Location of Demonstration of Community Scale Generation System at the Chemehuevi Community Center Project
(Source: Google Earth)

Activities associated with the project would include constructing three photovoltaic (90 kW total) carport structures over an existing parking area covering approximately 730 square feet, locating the battery energy storage (60 kWh) behind an existing building next to an existing backup generator, installation of an integrated battery management system and demand response inverter, and digging approximately 325 feet of trenches for conduit and electrical wires to connect the photovoltaic (PV) system and battery energy storage system.



Project Site Details
(Source: Chemehuevi Indian Tribe Environmental Assessment 2015)

The EPIC Program administered by the California Energy Commission provides funding for applied research and development, technology demonstration and deployment, and market facilitation for clean energy technologies and approaches for the benefit of ratepayers of Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company through a competitive grant solicitation process.

The California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.) applies to discretionary projects proposed to be carried out or approved by public agencies. The definition of a “project” includes an activity that may cause a direct or indirect physical change in the environment, which is supported in whole or in part through a grant from a public agency (Pub. Resources Code, § 21065). The CEQA Guidelines define a “public agency” as any state agency, board, or commission and any local or regional agency (Cal. Code Regs., tit. 14, § 15379). While CEQA applies to the Energy Commission, a state agency that proposes to fund the *Demonstration of Community Scale Generation System Project at the Chemehuevi Community Center*, it does not apply to the tribe.

To comply with the Tribal Ordinance, the Chemehuevi Indian Tribe conducted an environmental review according to their Environmental Policy Ordinance 2002.1. The ordinance requires the tribe’s assessment to include a:

> “...detailed report on the environmental impacts of the proposed action which is in substantial compliance with the requirements set out in the

National Environmental Policy Act [NEPA] (42 U.S.C. §4321, et seq.), the implementing regulations and guidance adopted by the Council on Environmental Quality, and the implementing regulations and guidance adopted by the Bureau of Indian Affairs, as they may be amended from time to time."

On July 24, 2015, the Chemehuevi Indian Tribe approved their Environmental Assessment (EA) of the proposed project and made a Finding of No Significant Impact (FONSI) based on the information in the EA. The EA/FONSI is included in Appendix "A" of this Initial Study.

Because the Chemehuevi Indian Tribe completed an analysis according to their own ordinance of the potential effects of the project on their own sovereign land, Energy Commission staff prepared an Initial Study that evaluates the potential effects to the environment located outside the tribal land. The discussion and analysis provided in this Initial Study use the term "offsite" to indicate areas outside tribal land. Based on Energy Commission staff's review, staff concluded that for the following environmental topic areas, the project would not result in any effects at offsite locations and/or could result in effects solely on tribal land and already considered in the EA/FONSI.

- Agriculture and Forestry Resources
- Biological Resources
- Cultural Resources
- Geology / Soils
- Greenhouse Gas Emissions
- Land Use / Planning
- Mineral Resources
- Population / Housing
- Public Services
- Recreation
- Utilities / Service Systems

FINDINGS:

This Initial Study found no significant offsite impacts to the environment from the proposed *Demonstration of Community Scale Generation System Project at the Chemehuevi Community Center*. No mitigation measures are required.

On the basis of this initial evaluation:

☒ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature Date

Printed Name For

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
I. Aesthetics. Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒

ENVIRONMENTAL SETTING

Visually, the area is predominantly rural in character. The community center and residential neighborhood surrounding the project site dominate the vertical viewscape in the project area. Open desert and Lake Havasu dominate views of the remainder of surrounding areas. Lake Havasu City Airport, the closest airport to the project site, is located approximately 4 miles to the northeast.

DISCUSSION

Would the project:

a) Have a substantial adverse effect on a scenic vista?

The site is located adjacent to developed, disturbed areas. Although located in a rural area of San Bernardino County, a mountain range located in the far background is visible beyond the project site to the west as viewed from Lake Havasu. However, the water level sits approximately 40 feet below the project site and views of the project site are obscured by a 40-foot high shoreline. Therefore, visual features in the project area consisting of a scenic vista or unique scenic resource (i.e., mountains) would not be affected with implementation of the proposed project. The project would not have a substantial adverse effect on a scenic vista.

NO IMPACT

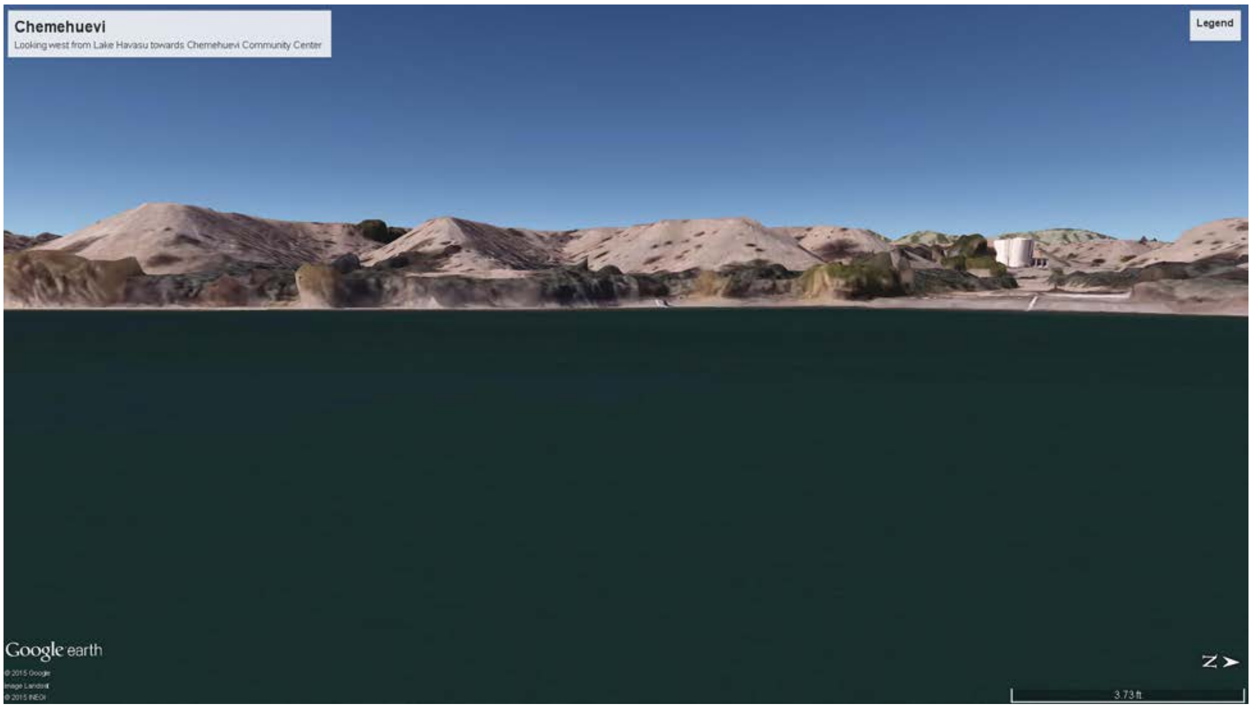
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?

The project site is not located within viewing distance of a California state highway. Highway 95 is located approximately 15 miles to the west. The project site is currently a disturbed, developed area and contains no significant scenic resource. The project would not damage a scenic resource within view of a state scenic highway.

NO IMPACT

c) Substantially degrade the existing visual character or quality of the site and its surroundings?

The project site is currently an open desert area within a residential neighborhood. The site is not visible from offsite areas, including from Highway 95 approximately 15 miles from the project site and from Lake Havasu located approximately 900 feet to the east. As shown in the simulated view from Lake Havasu below, the water level sits approximately 40 feet below the project site (Chemehuevi Community Center sits at approximately 500 feet above sea level, Lake Havasu sits at approximately 460 feet above sea level). Views from on the water toward the project site are obscured by a 40-foot high shoreline.



Simulated view towards project site looking west from Lake Havasu (Source: Google Earth)

Construction of the proposed solar facility at the existing Chemehuevi Community Center would not change the view from nearby areas as viewed from Lake Havasu and off tribal land (e.g., Highway 95). The proposed solar facility would not degrade the existing visual character or quality of the project area as viewed from offsite.

NO IMPACT

d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?

Solar panels manufactured today predominantly use an anti-reflective coated glass to cover the photovoltaic panel. The coated glass has low potential to reflect sunlight thereby creating minimum glare in the project area. The proposed solar facility would be designed so that the solar panels are in a fixed position facing to the south with the panels themselves fixed to their bases on the ground. The solar panels would not move to track the sun. The closest viewers off tribal land include boaters on Lake Havasu, who cannot see the project site itself, and residents in Havasu Landing approximately 1 mile south of the project site. Even though the front of the solar panels would face towards Havasu Landing, the distance to residents and the small footprint of the proposed solar panels would prevent the potential for creating visible glare. Therefore, the solar facility would not create glare that could affect daytime views from offsite.

NO IMPACT

MITIGATION MEASURES

None

CONCLUSION

The proposed CCC Project would not result in significant, adverse visual or aesthetic impacts.

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
III. Air Quality.				
Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations.				
Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

ENVIRONMENTAL SETTING

The project site would be located in the jurisdiction of the Mojave Desert Air Quality Management District (MDAQMD). The District's responsibilities include the control of air pollution from stationary sources and fugitive emissions from construction activities. The air quality in this region of San Bernardino County is considered to be "in attainment" for state and federal ambient air quality standards except for California's 24-Hour particulate matter (PM10) and ozone standards (ARB 2015c). Mobile sources such as trucks, automobiles and construction equipment, and their air pollutant emissions, are under the jurisdiction of the California Air Resources Board (ARB).

The two air pollutants of greatest concern in the MDAQMD are ozone and particulate matter. Ozone is an invisible secondary pollutant created by a chemical reaction that involves two precursor air pollutants (nitrogen oxides and reactive hydrocarbons) and sunlight. Ozone is a powerful respiratory irritant that can cause coughing, shortness of breath, headaches, fatigue and lung damage, especially among children, the elderly, the ill and people who exercise outdoors (ARB 2015a). Particulate matter contains fine material, metal, soot, smoke, and/or dust particles suspended in the air. Sources of particulate matter in the project area include on-road and off-road vehicles (e.g., engine exhaust, dust from unpaved roads), open burning of vegetation, residential wood stoves, and stationary industrial sources (e.g., factories). For health reasons, the air agencies are most concerned with particulate matter less than 10 and 2.5 microns in diameter (PM10 and PM2.5 respectively). Particles of these sizes can permanently lodge in the deepest, most sensitive areas of the lungs and cause respiratory and other health problems (ARB 2015b).

The project would add three new PV carport structures over parking spaces within an existing parking area. The project would not impact any undisturbed or undeveloped land. Additionally, all trenching and footing for the project would occur simultaneously, minimizing the period of soil disturbance to two weeks or less (CITER 2015a).

DISCUSSION

Would the project:

a) Conflict with or obstruct implementation of the applicable air quality plan?

b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?

Construction activities and operation of the proposed project would not violate the air quality plan of the MDAQMD. In addition, there would be no activities associated with construction or operation of the proposed project that would violate an air quality standard or contribute to an existing air quality violation. All construction activities and equipment (i.e. drill rig and trencher) would be required to comply with all rules and regulations of the MDAQMD and the ARB governing toxic air contaminants (such as those that could result from operation of construction equipment).

Conflict with or obstruct implementation of the applicable air quality plan: **NO IMPACT**

Violate any air quality standard or contribute substantially to an existing or projected air quality violation: Impacts would be **LESS THAN SIGNIFICANT**.

c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?

As mentioned previously, the MDAQMD is in non-attainment for California's 24-hour PM10 and Ozone standard. The area of disturbance on the project site would be of relatively small size, limited to trenching and drilling sites, and construction activities related to soil disturbance would be limited to a 2-week period. The use of a trencher and drill rig would create minimal amounts of particulate matter (i.e., dust). In addition, activities associated with the proposed project would not require any site grading. As such, construction activities would have limited potential to increase the emissions of an air pollutant for which the project region is in non-attainment and would not considerably increase the amount of these air pollutants in the project area.

Impacts would be **LESS THAN SIGNIFICANT**.

d) Expose sensitive receptors to substantial pollutant concentrations?

The proposed project is located within a previously developed area and construction activities would disturb a minimal amount of soil during trenching and drilling. As stated previously, the area of disturbance on the project site would be small in size, limited to trenching and drilling sites, and construction activities related to soil disturbance would be limited to a 2-week period. Activities associated with the Project would have a limited potential to affect sensitive receptors.

Impacts would be **LESS THAN SIGNIFICANT**.

e) Create objectionable odors affecting a substantial number of people?

The project would not involve any activities or sources that create objectionable odors.

NO IMPACT

MITIGATION MEASURES

None

CONCLUSION

The proposed CCC Project would not result in significant, adverse impacts to air quality.

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VIII. Hazards and Hazardous Materials				
Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☒	☐
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the	☐	☐	☐	☒

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
project result in a safety hazard for people residing or working in the project area?				
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized area or where residences are intermixed with wildlands?	☐	☐	☒	☐

ENVIRONMENTAL SETTING

The Chemehuevi Indian Reservation is located on an identified hazardous waste site. However, the area of concern, known as the Clear Bay Site, is located approximately two and half miles northwest of the proposed construction area.

DISCUSSION

Would the project:

a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?

The proposed project would use zinc bromine flow batteries. Flow batteries are rechargeable, scalable liquid batteries that store energy in chemical fluid elements, such as zinc and bromine, which would be kept in separate reservoirs within a battery stack. The battery stack contains electrodes through which the chemical fluid flows and in the process, electrochemically converts chemical energy to electrical energy resulting in stored energy in the battery. The zinc-bromine flow-battery energy storage (BES) unit that would be used as part of the proposed project contains a non-flammable aqueous electrolyte and would be enclosed in a multi-layer containment system to protect against combustion (CCC 2015, p. 6). This design would ensure safe operation of the battery system.

Impacts would be **LESS THAN SIGNIFICANT**.

b) Create a significant hazard to the public or the environment through reasonably forseeable upset and accident conditions involving the release of hazardous materials into the environment?

In case a battery leakage was to occur, the zinc-bromine flow BES unit would be enclosed in a multi-layer containment system and would incorporate an additional catchment system (CCC 2015, p. 6). These systems would provide protection against leaks and would prevent contamination of run-off. Although there is the very unlikely potential for an accident involving the release of a hazardous material, significant impact from such a hazardous materials release would be very unlikely because of the containment and catchment systems.

Impacts would be **LESS THAN SIGNIFICANT**.

c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?

The Chemehuevi Community School is approximately 200 feet from the BES unit. The zinc-bromine flow BES unit contains a non-flammable aqueous electrolyte and would be enclosed in a multi-layer containment system to protect against combustion. In addition, the BES incorporates an additional catchment system (CCC 2015, p. 6). These systems would provide protection against leaks and would prevent contamination of run-off. It would be unlikely the battery would emit hazardous components. If it did, however, exposure would be self-contained to the battery unit area and would not threaten people or structures.

Impacts would be **LESS THAN SIGNIFICANT**.

d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?

Staff reviewed two environmental hazard databases: the Department of Toxic Substances Control (DTSC) EnviroStor database and the Environmental Protection (EPA) EnviroMapper database. The EnviroStor database provides access to information about environmental clean-ups and permitted facilities in a community. The EnviroMapper database provides access to several EPA databases that provide information about environmental activities potentially affecting air, water, and land anywhere in the United States. According to these databases, the project site is included on a list of hazardous materials sites.

The Chemehuevi Reservation was historically used for Department of Defense (DOD) training. However, to what extent the reservation property was used was not well documented. DOD use most likely occurred during

World War II (WW II) by the Army and possibly in 1964 for Operation Desert Strike maneuvers. Live fire was not prohibited during WW II maneuvers; however, live fire was prohibited during Operation Desert Strike. Spent 50-caliber shells were observed during the site assessment inspections performed in 1997 and have also been discovered in the past. Evidence of unexploded (i.e., live) ordnance was not found at the Chemehuevi Reservation during 1999 inspections. The greatest amount of military debris was found within a 4,000-acre area called the Clear Bay Site. Live 50-caliber rounds may still lie within this area according to the *Defense Environmental Restoration Program Formerly Used Defense Sites Findings and Determination of Eligibility Report* (1999). The site has been classified with a risk assessment code (RAC) 4 because the known impacted areas are somewhat remote and unutilized (ENVIROSTOR 2015a). The RAC 4 describes the relative risk of injury, first aid or minor supportive medical treatment that could result from exposure to a hazard. RACs vary between a RAC 1 for a relatively high risk and RAC 5 for an insignificant risk (GFRAC 2015).

Although the Chemehuevi Indian Resevation is included on a list of hazardous material sites, the area of concern (Clear Bay Site) is located approximately two-and-a-half miles northwest of the proposed construction site. The RAC 4 classification of the Clear Bay Site does not propose a significant hazard to the public or the surrounding environment.

Impacts would be **LESS THAN SIGNIFICANT**.

e) For a project located within an airport's land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?

The project is not located within an airport's land use plan or within two miles of an airport.

NO IMPACT

f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?

The project is not located within the vicinity of a private airstrip. A private airstrip is located on the Chemehuevi Indian reservation more than two miles from the project site to the northwest.

NO IMPACT

g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?

The project would not provide any physical or hazardous material obstructions that would interfere with any emergency response plan or emergency evacuation plan. However, if a disaster were to occur, the completed project would generate power for the Community Center, which is also the Emergency Response Center for the Chemehuevi Tribe.

NO IMPACT

h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?

The zinc-bromine flow BES unit contains a non-flammable aqueous electrolyte and would be enclosed in a multi-layer containment system to protect against combustion (CCC 2015, p. 6). It would be unlikely that the zinc-bromine flow battery would cause a fire. If it did, however, the fire would likely be self-contained to the battery unit area and would not threaten people or structures.

While the project would not expose people or structures to a significant risk of wildland fires, it would provide power generation if the local utility grid went offline to CCC critical facilities, including the emergency response center, in the case of a fire or other disaster in the region.

Impacts would be **LESS THAN SIGNIFICANT**.

MITIGATION MEASURES

None

CONCLUSION

The project's Hazards and Hazardous Materials impacts would be less than significant.

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
IX. Hydrology and Water Quality				
Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☒	☐

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☒	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☒	☐

ENVIRONMENTAL SETTING

The project site is an existing parking lot at the Chemehuevi Community Center. The only soil disturbance would be for trenching and footing (CITER 2015a). (See Appendix A.) The project site is located less than 0.2 mile west of Lake Havasu, a Colorado River reservoir behind Parker Dam, and is outside of the Federal Emergency Management Act (FEMA) mapped floodway (FEMA 2008).

The site is approximately eight miles from Chemehuevi Peak (3,694 feet elevation) and located at the distal edge of its alluvial fan that extends east toward Lake Havasu. The site is located on a very low gradient slope of about 0.3% and at least 0.5 mile from any upslope blue-line stream (USGS, 2011).

During project operation, the PV panels would be washed as needed, based on a reduction in generation of more than 10%. It is anticipated that the panels would be washed three times a year, using approximately 180 gallons of water per washing event. The water used would be from the public water system (Alfredo Martinez-Morales, pers. comm., see Appendix D).

DISCUSSION

Would the project:

a) Violate any water quality standards or waste discharge requirements?

The project would be located within an existing parking lot, and the only soil disturbance would be for trenching and footing. The project would therefore not alter the existing drainage pattern in a way that would result in substantial erosion or siltation off-site or increase the rate or amount of surface run-off.

A zinc-bromine flow battery system would be installed on a concrete pad for use at the site. It would be fully contained and would include a catchment basin, which would provide protection against leaks and prevent contamination of run-off.

Impacts would be **LESS THAN SIGNIFICANT**.

b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?

The operational project would have no onsite personnel who would require potable water. While water would occasionally be needed for PV panel washing, the amount of water used would be minimal: approximately 180 gallons three times a year.

Impacts would be **LESS THAN SIGNIFICANT.**

c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?

d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?

e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?

f) Otherwise substantially degrade water quality?

The project would be located within an existing parking lot, and the only soil disturbance would be for trenching and footing. The project would therefore not alter the existing drainage pattern in a way that would result in substantial erosion or siltation off-site or increase the rate or amount of surface run-off.

A zinc-bromine flow battery system would be installed on a concrete pad for use at the site. It would be fully contained and would include a catchment basin, which would provide protection against leaks and prevent contamination of run-off.

Impacts would be **LESS THAN SIGNIFICANT**.

g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?

The project does not include housing and is not located within a FEMA-mapped floodway (FEMA 2008).

NO IMPACT

h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?

The project site is not located within a FEMA-mapped floodway (FEMA 2008). Also, the installation of a carport with PV panels and a small (1.03 meter by 1.14 meter) battery system would not impede or redirect flood flows. Carports are open structures, allowing water to flow through, and the battery system's footprint would be too small to significantly impact flood flows.

NO IMPACT

i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?

The project is not located within a FEMA-mapped floodway (FEMA 2008). Also, the project does not include habitable structures or structures of great value.

NO IMPACT

j) Inundation by seiche, tsunami, or mudflow?

The project is approximately 40 feet higher in elevation than Lake Havasu, making it unlikely to be inundated by seiche. A tsunami is not a concern due to the inland location of the project, and there are no steep slopes in the area that could cause mudflows.

The project site is not exposed to a significant mudflow or debris flow hazard. Mudflows and other mass wasting events usually result from substantial hillslope loading or increases in hillslope pore water pressure. The low annual rainfall and the quickly peaking rainfall style characteristic of the area is not likely to allow for hillslope saturation and subsequent failure. Furthermore, the lack of substantial vegetation mass or housing on the Chemehuevi slopes would also reduce the risk of substantial slope failure.

LESS THAN SIGNIFICANT IMPACT

MITIGATION MEASURES

None

CONCLUSION

The project’s Hydrology and Water Quality impacts would be less than significant.

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XII. Noise				
Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other	☐	☐	☒ Temporary Impacts	☒ Permanent Impacts

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
agencies?				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☒	☐
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐

ENVIRONMENTAL SETTING

The project would be constructed entirely on the Chemehuevi Indian Reservation. The project site sits approximately 900 feet inland of Lake Havasu, hidden from the waterline by a 40-foot elevated bank. The nearest residences offsite of the reservation are approximately 2 miles from the project site and under the jurisdiction of San Bernardino County.

Construction activities are estimated to take 2 months and would occur during weekday business hours.

Discussion:

a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?

c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?

d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?

Construction of the proposed project would generate temporary additional noise during business hours for the two-month construction period. The nearest residences offsite of the reservation are approximately 2 miles from the project site and under the jurisdiction of San Bernardino County. Section § 83.01.080 of the

San Bernardino County Code of Ordinances states that noisy activities which affect residential land designations may not exceed 55 dB between the hours of 7:00 a.m. to 10:00 p.m. Due to the distance of the project site from the nearest residences offsite of the reservation, noise impacts would be **LESS THAN SIGNIFICANT** during the construction phase.

The operations phase would generate **NO IMPACT** from noise due to the quiet nature of solar systems.

The construction period involving any soil disturbance would be minimized to two weeks or less. Activities such as trenching and footing would occur simultaneously to minimize the duration of any excessive offsite groundborne vibration or noise levels. There would be a **LESS THAN SIGNIFICANT IMPACT** from groundborne vibration and groundborne noise levels during construction.

MITIGATION MEASURES

None

CONCLUSION

The project's Noise impacts would be less than significant.

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XVI. Transportation/Traffic				
Would the project:				
a) Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?	☐	☐	☐	☒
c) Conflict with an applicable congestion management program, including, but not limited to, level of service (LOS) standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒

ENVIRONMENTAL ISSUES	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
d) Substantially increase hazards due to a design feature (e.g., sharp curves, dangerous intersections, or glint and glare) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?	☐	☐	☐	☒
g) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒

ENVIRONMENTAL SETTING

The proposed project is located approximately 900 feet west of Lake Havasu, adjacent to low-density residential development in a mostly rural area. Regional access to the project site is from Highway 95, which runs in a north-south direction approximately 15 miles west of the project. From Highway 95, vehicles would travel eastbound on Havasu Lake Road, which turns north near its end before turning into Chemehuevi Trail. Traffic would then head north on Chemehuevi Trail, turning east on Sunrise Trail and south on North Valley Mesa to access the site. The site can also be accessed locally by a pedestrian walkway linking the small residential neighborhood along Paloverde Lane to the Chemehuevi Community Center.
The nearest airports are the Chemehuevi Valley Airport, located approximately 2.3 miles northwest of the site, and the Lake Havasu City Municipal Airport, located approximately 4 miles northeast of the site.

A crew of five workers would construct the project over a maximum construction period of two months. Construction staff would commute from the surrounding area, such as the Coachella Valley, which is located approximately 125 miles southwest of the project (Alfredo Martinez-Morales, pers. comm., see Appendix B). (See Appendix A.) Workers from the Coachella Valley would travel eastbound on Interstate 10 for approximately 100 miles, turning northbound onto Highway 95 at the city of Blythe to access the project site.

There would be eight truck deliveries during construction for delivering the solar PV system components, the carport structures, and the battery system components. All truck deliveries would occur during a two-week period (Alfredo Martinez-Morales, pers. comm., see Appendix D).

The completed project would require no new operational employees or truck deliveries.

DISCUSSION

Would the project:

a) Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?

Project construction traffic would be minimal. The project would employ only five construction workers, resulting in a maximum of five construction worker roundtrips per workday if each construction worker commuted individually. Truck trips would also be minimal, with an estimated eight truck deliveries occurring during the construction period. This additional traffic would be negligible, temporary, and would not impact level of service on nearby roads or Highway 95. During operations, the project would not generate any additional trips.

Impacts would be **LESS THAN SIGNIFICANT**.

b) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?

Due to the negligible increase in traffic generated by the project and the fact that construction and operation of the project would occur on Chemehuevi Indian Tribe property (not in any public right-of-way, etc.), the project would not conflict with any applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of the circulation system.

NO IMPACT

c) Conflict with an applicable congestion management program, including, but not limited to, level of service (LOS) standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?

The project would add a temporary negligible increase in traffic during construction (a maximum of five construction worker roundtrips per workday and only eight truck deliveries during the entire construction period) and no additional traffic during operation. Roadway level of service would not be affected.

NO IMPACT

d) Substantially increase hazards due to a design feature (e.g., sharp curves, dangerous intersections, or glint and glare) or incompatible uses (e.g., farm equipment)?

There would be no increase in hazards due to a design feature or incompatible uses. PV panels can generate glare that in some cases appears similar to bodies of water and reflections from glass, which under certain conditions, can pose hazards to motorists or pilots by distracting them or at worst, temporarily causing vision impairment. The proposed PV panels, however, would be located on top of carport structures where they would be unlikely to be seen by motorists, especially motorists outside of the reservation, who would be at least one mile from the project given the reservation boundaries and location of Lake Havasu. Boaters on Lake Havasu would be unable to view the PV panels both because of the panels' location on top of the carport and because views of the project site from on Lake Havasu are obscured by a 40-foot-high shoreline. Furthermore, the nearest airports are more than two miles away from the site, so glare from solar panels would not affect aircraft on departure or landing.

NO IMPACT

e) Result in inadequate emergency access?

The proposed project would not physically block any access roads or result in traffic congestion which could compromise timely access to this facility or any other location.

NO IMPACT

f) Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?

The proposed project would not result in any conflict with adopted policies, plans, or programs supporting alternative transportation. Improvements would occur on-site and would not interfere with any mode of alternative transportation.

NO IMPACT

g) **Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?**

The project would not generate additional air traffic and would not encroach on airport land, as the nearest airports are more than two miles away. The PV panels are low in height and would not interfere with aircraft flights or air traffic patterns, or require review by the Federal Aviation Administration under Title 14, Part 77 of the Code of Federal Regulations.

NO IMPACT

MITIGATION MEASURES

None

CONCLUSION

The project's Transportation and Traffic impacts would be less than significant.

REFERENCES

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ARB 2015b – California Air Resources Board http://www.arb.ca.gov/research/aaqs/caaqs/ozone/ozone.htm, accessed August 4, 2015.

ARB 2015c – California Air Resources Board http://www.arb.ca.gov/research/aaqs/caaqs/pm/pm.htm, accessed August 4, 2015.

CCC 2015 – Demonstration of Community Scale Low Cost Highly Efficient PV and Energy Management System at the Chemehuevi Community Center (CCC). Submitted as a University of California Riverside grant proposal. (See Appendix C.)

CITER 2015a – Chemehuevi Indian Tribe Environmental Assessment: California Environmental Quality Act (CEQA) Compliance From for the Chemehuevi Community Center Project, accessed July 24, 2015. (See Appendix A.)

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FEMA 2008. Federal Emergency Management Agency, Flood Insurance Rate Map 06071C6400H. Revised August 28, 2008.

GFRAC 2015 – Guidelines for Risk Assessment Codes http://www.compliance.gov/forms-pubs/eresources/rac_guidelines.pdf , accessed August 3, 2015.

MDAQMD 2015 – Mojave Desert Air Quality Management District, http://www.mdaqmd.ca.gov/index.aspx?page=395, accessed July 30, 2015.

SBCCO 2015 – San Bernardino County Code of Ordinances, Section § 83.01.080, http://www.amlegal.com/sanbernardinocounty_ca/, accessed on August 3, 2015

USGS 2011. United States Geological Survey, Castle Rock 7.5-Minute Quadrangle, 2011.

APPENDIX A:

CHEMEHUEVI INDIAN RESERVATION ENVIRONMENTAL ASSESSMENT

CHEMEHUEVI INDIAN TRIBE

ENVIRONMENTAL ASSESSMENT

The purpose of this report is to comply with the Chemehuevi Indian Tribe Environmental Policy in accordance with the provisions and regulations stipulated in the National Environmental Policy Act (NEPA) Implementation Instructions

The content of this document were reviewed by the Chemehuevi Indian Tribe's Vice Chairman, Glenn Lodge (760) 858-1116 and the Tribe's Director of Planning, Mr. William Cox (760) 858-1116.

Section I: Project description

This proposed community scale micro grid project thoughtfully integrates advanced pre-commercial photovoltaics (PV) and battery energy storage providing combined benefits to the community, utility, and ratepayers. The components are carefully chosen to optimize flexibility in energy management while demonstrating the unique characteristics of each technology and their advancement compared to standard commercially available products. This proposed project called *Demonstration of Community Scale Generation System at the Chemehuevi Community Center* will deploy and demonstrate three energy components:

1. 90 kW advanced PV deployment on carport structures;
2. 60 kWh Battery Energy Storage (BES) with integrated Battery Management System (BMS) and Demand Response (DR) inverter; and,
3. Power Management System integrated with OSIsoft PI Software database and control.

The PV and BES system components will be developed to function autonomously under the control of the Power Management System. While the two systems will be interdependent for determination of the control state, the PV and BES can function independently. The installed system will integrate and manage: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities at the demonstration community. The demonstration site is the Chemehuevi Community Center (Figure 1), which is also the Emergency Response Center in the Chemehuevi Indian Tribe (CIT). The integration and deployment of two pre-commercial solar PV technologies along with BES permits flexibility in Energy Management System (EMS) optimization.

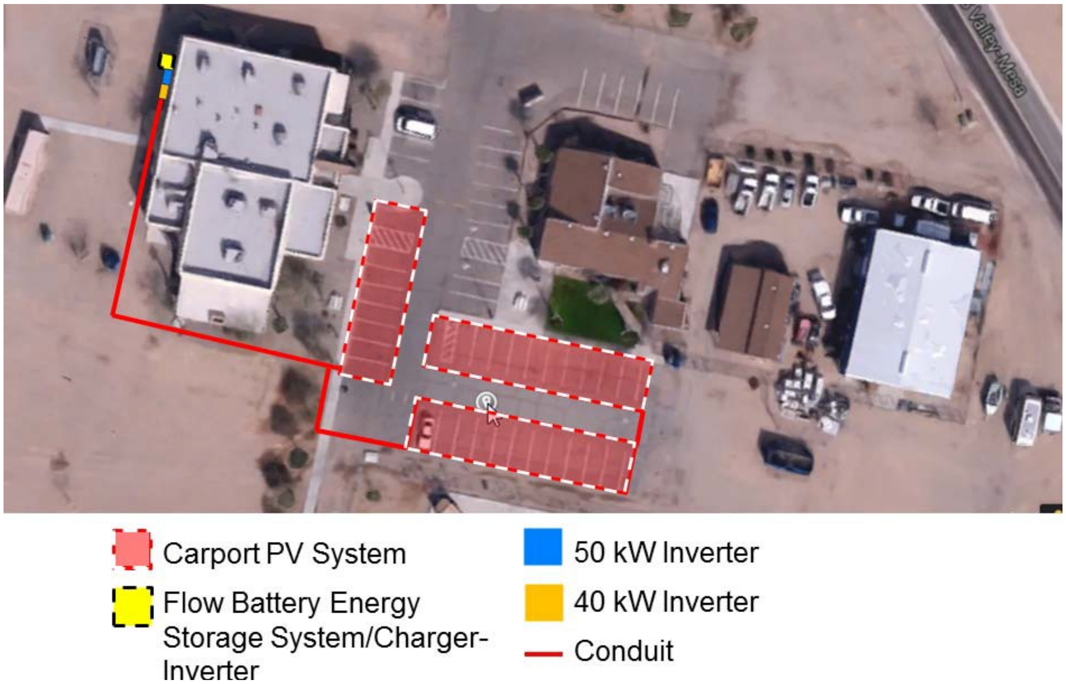

Figure 1. Project location at the Chemehuevi Community Center (Source: Google Maps)

The project partners have significant expertise in energy generation and storage, power conversion, energy management, communication and control deployments. This Project and proposed architecture will maximize the benefits available through advanced strategies for energy management by combining solar energy and flow-battery technologies. The Project employs expertise, knowledge, and deployment skills previously demonstrated by the Project team including demand response, battery energy to grid, and smart control (i.e. peak shaving and load shifting). The pre-commercial generator technologies will be provided by the Project partners (Cogenra and Solexel) and will be coupled with a BES provided by the project partner (Primus Power) with an appropriate control system. The advanced energy management strategies will be implemented by University of California Riverside (UCR) in collaboration with OSIsoft. Integrated energy management strategies, control software, and micro grid development have been demonstrated by UC Riverside in their Sustainable Integrated Grid Initiative (SIGI) smart micro grid deployment. This project harnesses the expertise of those at the forefront of: energy generation and storage, energy management, regulation and conditioning, demand response, and micro grids. UC Riverside will oversee and manage all tasks and financial obligations and ensure deliverables from sub-contractors are met. UC Riverside will coordinate installation at the demonstration site and oversee operational data and system performance. UCR will complete all reporting, validation, and quantification of system results.

Section II: Checklist

Chemehuevi Environmental Assessment Checklist

Environmental Issue	No Effect	Less than Significan	Significant
Aesthetics		X	
Agricultural Resources	X		
Air quality		X	
Biological Impacts	X		
Cultural/Historical Resources	X		
Geology and Soils	X		
Hazardous/Toxic Materials		X	
Hydrology/Water Quality		X	
Land Use Planning	X		
Mineral Resources	X		
Noise		X	
Population Growth and Housing	X		
Public Health/Hazards	X		
Public Services/Utilities	X		
Recreation	X		
Transportation/Traffic		X	

Identify presence or absence of the following within the area potentially affected by the proposed action:

U Floodplains?

There are no floodplains in the project area where the solar array or battery energy storage is sited.

V Wetlands?

There are no wetlands in the project area. The project area is developed land (i.e. existing parking lot).

W Threatened, endangered, or candidate species and/or their critical habitat?

There are no threatened, endangered, or candidate species listed for this area. There is no critical habitat within the project area.

X Areas of recreational, ecological, scenic, or aesthetic importance?

There are no areas of recreational, ecological, scenic, or aesthetic importance within the project area.

Y Natural resources (timber, fish, wildlife, waterbodies or aquifers)?

There are no natural resources (timber, fish, wildlife, waterbodies or aquifers) within or immediately adjacent to or underneath the project area.

Z Property of historic, archaeological, or architectural significance?

There is no property of historic, archaeological, or architectural significance within the project area.

AA Minority and low-income populations?

There are no minority and low-income populations within the project area. The vicinity includes the Community Center and Housing Department, which will benefit from the project by providing a power source. Residential homes surround the location on all sides, but are not close enough to have substantial impacts from the project.

Section IV: Environmental Effects

Identify the potential effects, including cumulative effects, to the affected environments identified in the checklist in Section II and Section III. Short-term and long-term effects should be described, as well as both beneficial and adverse impacts on the environment and public health and safety.

Background

The Project location is fully developed and has undergone a previous EIR and environmental assessment during prior development. The site currently consists of paved parking and the Chemehuevi Community Center building. During the most recent site development a full environmental review was completed. To comply with the Tribal Ordinance, CIT conducted an environmental review according to their Environmental Policy Ordinance 2002.1 ADOPTED 2002-01-24. The ordinance requires the tribe's assessment to include a:

"...detailed report on the environmental impacts of the proposed action which is in substantial compliance with the requirements set out in the National Environmental Policy Act [NEPA] (42 U.S.C. §4321, et seq.), the implementing regulations and guidance adopted by the Council on Environmental Quality, and the implementing regulations and guidance adopted by the Bureau of Indian Affairs, as they may be amended from time to time."

The current proposed project lies within the previous development area and does not impact any undisturbed land or undeveloped land. The proposed effort intends to enhance the existing facilities with PV carport structure over the existing developed parking spaces. The proposed Battery Energy Storage is proposed to be located behind the building next to the existing backup generator. The proposed BES will have a footprint of equal or smaller size than the existing generator. All additional proposed site improvements include wiring and energy management components to support the PV and BES installations.

SECTION II Topics

Aesthetics

Potential effects: Visually, the area is predominantly rural in character. The vicinity includes the Community Center and Housing Department, which will benefit from the project by providing a power source. Residential homes surround the location on all sides, but are not close enough to have substantial impacts from the project. Depending on the angle of the solar panel carport with respect to the sun, the homes to the south may be occasionally impacted from the glare of the reflection.

Adverse short-term effects/impacts: During installation, the construction site will be visible.

Beneficial short-term effects/impacts: Tribal members will be interested in the improvements being made to the community center.

Adverse long-term effects/impacts: The site is located adjacent to developed, disturbed areas. Although located in a rural area of the Chemehuevi Valley, there are no visual features in the project area consisting of a scenic vista or unique scenic resource. The project would not have a substantial adverse effect on a scenic vista.

Beneficial long-term effects/impacts: Solar Energy deployment is viewed as progressive, sustainable, and environmental friendly. This project will contribute to the excitement and momentum toward the adoption of renewable energy for community-scale applications.

Cumulative effects: Positive improvement to site aesthetics with shading to the parking area.

Agricultural Resources

Potential effects: None. The site is located on a developed, disturbed area (i.e. parking lot) and does not impact any agricultural resources.

Adverse short-term effects/impacts: None. **Beneficial**

short-term effects/impacts: None. **Adverse long-term**

effects/impacts: None.

Beneficial long-term effects/impacts: None. There are no current agricultural resources present or impacted.

Cumulative effects: None.

Air Quality

Potential effects: During construction, dust particles could be created.

Adverse short-term effects/impacts: There could be dust particles created during business hours.

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Biological Impacts

Potential effects: None. There are no wetlands or special status species present at the project site.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Cultural/Historical Resources

Potential effects: None. The site is located on a developed, disturbed area (i.e. parking lot) and does not impact any cultural/historical resources.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Geology and Soils

Potential effects: Temporary ground disturbance during construction, for trenching.

Adverse short-term effects/impacts: Temporary ground disturbance during construction, for trenching.

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None. **Beneficial**

long-term effects/impacts: None.

Cumulative effects: None.

Hazardous/Toxic Materials

Potential effects: The zinc-bromine flow battery elements that are combined to make up the battery storage system are fully contained, controlled, and monitored. The system is small, self-contained, and semi-sealed, making leaks highly unlikely. The electrolyte volumes utilized in this project fall below thresholds requiring special consideration under USDOT or EPA regulations.

The tribe has adopted the International Building Code (IBC) and would issue the project a building permit ensuring compliance with these codes.

Adverse short-term effects/impacts: Extremely low potential for leaks or fire.

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: Extremely low potential for leaks or fire.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Hydrology/Water Quality

Potential effects: There would be minimal planned water use during operation for cleaning panels. Any water used during operation would be minimal. A contained battery with a catchment system would make leaks that could contaminate the water system highly unlikely.

Adverse short-term effects/impacts: Extremely low potential for battery leaks.

Beneficial short-term effects/impacts: None.

Adverse long-term effects/impacts: Extremely low potential for battery leaks. Minimal water use for

cleaning panels.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Land Use Planning

Potential effects: The 90 kW solar array will be a permanent carport structure on developed, disturbed land.
Adverse short-term effects/impacts: None. **Beneficial**

short-term effects/impacts: None. **Adverse long-term**

effects/impacts: None.

Beneficial long-term effects/impacts: The carport solar array will provide shading to the Chemehuevi Tribe members.

Cumulative effects: Positive. This project is consistent with the Chemehuevi Tribe's land use planning and economic development strategic plans.

Mineral Resources

Potential effects: None. There are no mineral resources impacted by this project.

Adverse short-term effects/impacts: None.
Beneficial short-term effects/impacts: None.

Adverse long-term effects/impacts: None. **Beneficial**

long-term effects/impacts: None.

Cumulative effects: None.

Noise

Potential effects: Temporary construction-related noise during the weekday business hours only. This increase in noise will be minimal over the typical noise level in the project area.
Adverse short-term effects/impacts: Temporary construction-related noise, a minimal increase over typical noise in the project area. Staff at the Community Center and Housing Department may hear the construction-related noise.
Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None

Beneficial long-term effects/impacts: The Micro grid system will provide uninterrupted power to the Chemehuevi Community Center, which is designated as the emergency response facility at the Tribe.

Cumulative effects: Positive. It is anticipated that the Micro grid system will reduce the operation of the diesel back-up generator at the Chemehuevi Community Center.

Population Growth and Housing

Potential effects: None. The site is located on a developed, disturbed area (i.e. parking lot) and is not considered a future housing development area.
Adverse short-term effects/impacts: None. **Beneficial**

short-term effects/impacts: None. **Adverse long-term**

effects/impacts: None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Public Health/Hazards

Potential effects: Improved public health through replacement of fossil fuels with renewable energy and reduced GHG emissions, by reducing/eliminating the use of the diesel back-up generator at the Chemehuevi Community Center. Improved community resiliency through onsite emergency power. The flow battery has liquid chemicals contained within the system, completely surrounded by casing and additional containment.
Adverse short-term effects/impacts: Extremely low potential for leaks or fire from battery system

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None. Extremely low potential for leaks or fire from battery system.

Beneficial long-term effects/impacts: None

Cumulative effects: Positive. Improved public health through replacement of fossil fuels with renewable energy and reduced GHG emissions, by reducing/eliminating the use of the diesel back-up generator at the Chemehuevi Community Center. Improved community resiliency through onsite emergency power.

Public Services/Utilities

Potential effects: Temporary, intermittent use of back-up power (e.g. diesel generator) during construction. Increased resiliency created for onsite electric services/utilities. Potential economic savings with micro grid demand response and lowest cost of energy balancing.

Adverse short-term effects/impacts: Temporary, intermittent use of back-up power (e.g. diesel generator) during construction.

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None.

Beneficial long-term effects/impacts: Increased reliability; energy savings; long-term emergency power onsite

Cumulative effects: Positive, through overall increased reliability and reduced cost

Recreation

Potential effects: None. The project area is not designated or envisioned for any type of recreational use.
Adverse short-term effects/impacts: None. **Beneficial**

short-term effects/impacts: None. **Adverse long-term**

effects/impacts: None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Transportation/Traffic

Potential effects: Small increase in traffic during the construction phase.

Adverse short-term effects/impacts: Some increase in traffic on existing access roads during the construction phase.

Beneficial short-term effects/impacts: None.
Adverse long-term effects/impacts: None.
Beneficial long-term effects/impacts: None.

Cumulative effects: None. Post construction there will be no increase in traffic to the site.

SECTION III Topics

Floodplains

Potential effects: Soils encountered at the site would be expected to consist of highly weathered floodplain alluvium that is susceptible to erosion and offsite sedimentation. During a rain event the rain water falling onto the site that has substantial time to drain naturally into the ground.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: The solar Microgrid system will provide uninterrupted emergency power to the Chemehuevi Tribe.

Cumulative effects: None.

Wetlands

Potential effects: None. There are no wetlands in the project area.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Threatened, endangered, or candidate species and/or their critical habitat

Potential effects: None. There are no threatened, endangered, or candidate species. The project area does not include any critical habitat

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Areas of recreational, ecological, scenic, or aesthetic importance

Potential effects: None. There are no areas of recreational, ecological, scenic, or aesthetic importance within the project area.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Natural resources (timber, fish, wildlife, waterbodies or aquifers)

Potential effects: None. There are no natural resources (timber, fish, wildlife, waterbodies or aquifers) within or immediately adjacent to the project area.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Property of historic, archaeological, or architectural significance

Potential effects: None. There is no property of historic, archaeological, or architectural significance within the project area.

Adverse short-term effects/impacts: None. **Beneficial short-term effects/impacts:** None. **Adverse long-term effects/impacts:** None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Minority and low-income populations

Potential effects: None. There are no minority and low-income populations within the project area. **Adverse short-term effects/impacts:** None. **Beneficial**

short-term effects/impacts: None. **Adverse long-term**

effects/impacts: None.

Beneficial long-term effects/impacts: None.

Cumulative effects: None.

Section V: Scoping/Public Comment

Describe and document public meeting, notices, etc. held to discuss proposed project with the community, and address comments that came up during this process.

The CIT is following standard procedure for community development projects. The project description has been posted and disseminated in the Tribal newsletter with committee review during monthly meetings. The progress of the project is updated regularly during the monthly Tribal committee review. The real estate and development office addresses any concerns associated with the proposed development. Local community members are encouraged to join the committee meetings and express any concerns regarding the proposed project.

Section VI: Mitigation

Describe in detail any plans for mitigation of potential environmental impacts for the proposed project.

While the project is intended to have minimal environmental impacts the following mitigations measures will be implemented:

AA.S. The parking lot carport installation will be phased to minimize the impacted region on any specific day. Appropriate signage and barriers will be placed to minimize impact on site visitors.

AA.T. The period of construction for carports and Battery Energy Storage will be minimized to two months or less. The carport installation will be coordinated to occur prior to PV installation with all trenching and footing occurring simultaneously. The period of any soil disturbance should be minimized to two weeks or less.

AA.U. The BES will be configured and installed with the manufacturer recommended concrete pad and catchment basin. The BES will be located behind the building in the vicinity of the current backup generator. Visual impact and security will be enhanced with an enclosure around the BES.

AA.V. Any construction noise and traffic will be limited to weekday business hours. Special attention will be given to events planned for the community center and avoid construction during high volume occasions.

AA.W. The proposed project is considered an environmental benefit to the Chemehuevi Indian Tribe by providing a higher degree of renewable energy generation with improved energy storage and management.

July 23, 2015

Section VII: **Signatures and Approvals**

Once the report is completely filled out, sign and date and turn in to the Tribal Environmental Director. The Environmental Director will review, sign, and date it, adding comments if necessary, and turns it in to the Tribal Chairman with the decision indicated below. The Tribal Chairman will review the Environmental Assessment and Environmental director's decision and comments and sign and date the document indicating whether the decision reached is the same as that of the Environmental Director. When the report is complete it should be copied so that one copy can be filed with the Environmental Programs Office and the other with the project plans.

Person or person who prepared this report:

Bill Cox, Director of Planning, Chemehuevi Indian Tribe

Tribal Environmental Director: Decision /(__ FONSI

______________________________ ______EIS need

Council Chairman

____

APPENDIX B:

AUGUST 5th E-MAIL BETWEEN ALFREDO MARTINEZ-MORALES AND HASSAN MOHAMMED

From: Alfredo Martinez-Morales [mailto:alfmart@ece.ucr.edu]
Sent: Thursday, August 06, 2015 4:04 PM
To: Mohammed, Hassan@Energy
Cc: Mike Todd; Sadrul Ula; Glenn Lodge; dir.epa@cit-nsn.gov
Subject: Re: Grant Agreement EPC-15-003 with UC Riverside - Review of Tribe's Environmental Assessment

Hi Hassan,

Below are the answers to the questions from Eric. The only pending item is to provide a map showing the boundaries of the Clear Bay Site.

Steven Escobar, who is the Chemehuevi Environmental Director, will assist us to provide this map soon. He was out of this office today, but we will contact him tomorrow morning.

Regards,

Alfredo

--
Alfredo A. Martinez-Morales, Ph.D.
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507
Tel. (951) 781-5652; Fax (951) 781-5790

From: Alfredo Martinez-Morales
Sent: Wednesday, August 5, 2015 6:29 PM
To: Glenn Lodge (citvicechair@gmail.com); tribe@citlink.net; dir.epa@cit-nsn.gov
Cc: Mike Todd; Glenn Lodge (citvicechair@gmail.com)
Subject: Re: Grant Agreement EPC-15-003 with UC Riverside - Review of Tribe's Environmental Assessment

Glenn and Steve,

Could you please review the answers (in RED)? If you agree with the answers, we can send them to CEC.

Alfredo

Project Description

How much money is the EPIC grant agreement for?

$2,588,906.00

Who is the EPIC grant agreement with (UC Riverside or Chemehuevi Indian Tribe)?

UC Riverside

What is the street address for the Chemehuevi Community Center?

1975 S Valley-Mesa, Needles, CA 92363

What is the mailing address for the Chemehuevi Community Center?

1975 S Valley-Mesa, Needles, CA 92363

Air Quality

What construction equipment (e.g., excavator) is anticipated to be used?

Caisson Drill Rig (x1)

Trencher (x1)

Hydrology and Water Quality

How much grading will be done, if any? Please provide a numerical estimate.

None

Would best management practices for erosion control be used?

N/A

What is the footprint size of the battery energy storage system?

The flow battery' footprint is 1.03 m (W) x 1.14 m (L)

Traffic / Transportation

How many construction workers are anticipated?

A small crew of 5 construction workers.

What is the location of where contractor(s) and/or workers would come from, if known?

From the surrounding area (e.g. Palm Desert/Coachella Valley)

Hazards and Hazardous Materials

Please provide a map showing the boundaries of the Clear Bay site. This area consists of 4,000 acres and contains the highest concentration of Department of Defense (DOD) litter (e.g. spent shells and tank tracks).

Steven Escobar will help us to provide a map.

Alfredo

--
Alfredo A. Martinez-Morales, Ph.D.
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507
Tel. (951) 781-5652; Fax (951) 781-5790

APPENDIX C:

University of California Riverside Grant Proposal

Demonstration of community scale low cost highly efficient PV and energy management system at the Chemehuevi Community Center (CCC).

Proposal submitted in response to **Program Opportunity Notice PON-14-307**

Principal Investigator
Alfredo Martinez-Morales
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
CE-CERT
Mail Code 022
University of California
Riverside, CA 92521
(951) 781-5676
alfmart@ece.ucr.edu

Authorized Representative
Ms. Ursula Prins
Principal Contract and Grant Officer
Office of Research and Economic Development
200 University Office Building
University of California
Riverside, CA 92521
(951) 827-4808
Ursula.prins@ucr.edu

Submitted January 16, 2015

ATTACHM ENT 1
Application Form

This form provides the Energy Commission with basic information about the applicant and the project. Each applicant must complete and sign this attachment. If an applicant submits multiple applications, each application must be for a distinct project (i.e., no overlap with respect to the tasks described in the Scope of Work, Attachment 6).

Aoplicant's Identification Information		
Legal Name	**The Regents of the University of California**	
Status	D Private Company D Non-profit California State Agency *(includes the University of California and California State University)* D Government Entity *(e.g., city, county, federal government, air/water/school district, joint power authority, out-of-state university)*	
Federal Tax ID #	**956006142**	
Project Manager *(serves as the point of contact for all communications)*	Name	Alfredo Martinez-Morales, Ph.D.
	Street Address	1084 Columbia Ave.
	City, State, and Zip Code	Riverside, CA, 92507
	Phone/ Fax Numbers	Phone: (951) 781-5652 Fax: (951) 781-5790
	E-Mail Address	alfmart@cert .ucr.edu

Proiect Title
Demonstration of community scale low cost highly efficient PV and energy management system at the Chemehuevi Community Center (CCC)

Proposed Term *(must fall within the dates specified in the "Key Activities Schedule" in Part I of the solicitation.)*	
Start Date: 07/01/15	**End Date: 07/31/18**

Project Location	
Street Address	**1978 Valley Mesa Rd.**
City, State, and Zip Code	**Havasu Lake, CA 92363**
Pilot Testing/Demonstration/Deployment Projects bnly: Specify the location of the pilot test, demonstration, or deployment site(s) below, if different from above. Expand this chart if necessary.	
Street Address	*Same as above*
City, State, and Zip Code	*Same as above*
IOU Service Territory	D Pacific Gas and Electric Co. Southern California Edison Co. D San Diego Gas and Electric Co.

Project Description *(brief paraqraph)*
This proposed project called ***Chemehuevi Community Project***, hereafter the Project, will deploy and demonstrate 50 kW mid-concentration solar PV system, 40 kW high-performance solar PV system, and 60 kWh/30 kW flow-battery energy storage system

and manage: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities at the demonstration community. The demonstration community dedicated to this project consists of a single facility with an average energy consumption 102,000 kWh/year and adjacent buildings (energy consumption TBD). The main facility is the Chemehuevi Community Center (CCC), which is designated as the Emergency Response Center in the Chemehuevi Indian Tribe. The integration and deployment of two pre-commercial solar PV technologies permits optimum flexibility in energy management while demonstrating the unique characteristics of each technology and their advancement compared to standard commercially available products. In addition, the FBESS can meet demand response and energy management requests while critical load at the CCC is being utilized and maintained, minimizing operational impacts to the Community Center.

Funding *(See the "Funding" section in Part I of the solicitation)*		
Project Group *(select only **one**)*	☐ Group1: Proposals with the demonstration community located entirely within a region with the poorest environmental quality as defined by a CalEnviroScreen 2.0 in the 81 or greater percentile range. Identify the census tract. ☒ Group 2: All Proposals with a demonstration community not eligible under Group 1.	
Amount Requested	**$ 2,588,906**	
Match Funding *(The amount must be consistent with the amount or dollar value described in any match funding commitment letters. See Attachment 11.)*	**$ 706,698**	
	☐ Cash in hand ☐ Equipment ☒ Materials ☒ Information technology services	☐ Travel ☒ Subcontractor costs ☒ Contractor/Project Partner in-kind labor Costs ☐ Advanced practice costs

1. Are the proposed activities considered a "project" under CEQA (i.e., do they have the potential to cause a direct or a reasonably foreseeable indirect physical change in the environment)? *See California Public Resources Code Section 21065 and 14 California Code of Regulations Section 15378 for a definition of "project."* ☐ Yes: skip to question 2. ☒ No: complete the sentence below. The activities funded by the agreement will not cause a direct physical change in the environment because this project deals with solar deployment, energy management and data management systems in existing facilities, under the jurisdiction of the Chemehuevi Indian Tribe.
2. If the proposed activities are considered a "project" under CEQA and are not exempt, has the required environmental review been completed?

☐ Yes (provide the documentation required in Attachment 8, CEQA Compliance Form) ☐ No. (explain why no documentation has been prepared where indicated on Attachment 8)

Subcontractors *(If subcontractors will perform work for the project, insert the legal name of each subcontractor below.)*
Cogenra Solar
Solexel
Primus Power
OSIsoft, LLC

Name of Applicant or Subcontractor	**Name of Entity that Issued the Agreement, Contact Name, and Phone Number**	**Description of Project and Status**
The Regents of the Univeristy of California (UC Riverside)	South Coast Air Quality Management District	The New Grid: Integrating Photovoltaics, Energy Storage, and a Local Utility for Electric Transportation (Barth PI, Ula Co-PI) (active)
The Regents of the Univeristy of California (UC Riverside)	California Department of Transportation	High Occupancy Vehicle System Analysis (Barth) (completed)
The Regents of the Univeristy of California (UC Riverside)	California Transportation Commission	Research and Develompent of an Alternatifve Fuel Fleet Monitoring System (Barth) (completed)
The Regents of the Univeristy of California (UC Riverside)	U.S. Department of Energy	Next Generation Environmentally Friendly Driving Feedback Systems Research and Development (Barth) (active)
The Regents of the Univeristy of California (UC Riverside)	U.S. Department of Energy and California Department of Transportation	Developiong a Model to Quantify Emissions from Heavy-Duity Construction Equipment (Barth) (active)
The Regents of the Univeristy of California (UC Riverside)	South Coast Air Quality Management District	Technical Assistance for Advanced, Low- and Zero-Emission mobile and Stationary Source Technologies (Barth) (active)

		(active)
The Regents of the Univeristy of California (UC Riverside)	California Transportation Commission	Reducing Uncertainty in Modeling Vehicle Emissions at High Speed in California (Barth) (completed)
The Regents of the Univeristy of California (UC Riverside)	California Transportation Commission	Air Quality: The Effectiveness of Managed lanes in California (Barth) (completed)
The Regents of the Univeristy of California (UC Riverside)	Clean Energy Research Associates (prime on CEC EISG)	Testing and Validation of a Replacement Technology for Solar Thermal Plants (Ula and Martinez-Morales)
The University of California, Riverside, has approximately 46 active contracts and grants with State of California government agencies and approximately 35 active contracts and grants with the U.S. Department of Energy. Typically, we have one contract per year with Riverisde Public Utilities, and occasionally we have projects with the Southern California Public Power Authority. The list above shows only the current and recent projects of the Principal Investigators for this project.		

Certifications

1. I am authorized to complete and sign this form on behalf of the applicant.
2. I authorize the California Energy Commission to make any inquiries necessary to verify the information presented in this application.
3. *General Applicants Only:* I have read and understand the terms and conditions contained in this solicitation. I accept the terms and conditions contained in this solicitation on behalf of the applicant, and the applicant is willing to enter into an agreement with the Energy Commission to conduct the proposed project according to the terms and conditions without negotiation.
4. *University of California! U.S. Department of Energy Applicants Only:* I understand that the terms and conditions applicable to the University of California and the U.S. Department of Energy National Laboratories are in negotiation and will be posted once finalized. If the applicant is not willing to enter into an agreement with the Energy Commission to conduct the proposed project according the terms and conditions without negotiation, it will not receive an award under this solicitation.
5. To the best of my knowledge, the information contained in this application is correct and complete.

Signature of Authorized Representative	[signature] Date: 1/15/15
Printed Name of Authorized Representative	Ursula N. Prins

ATTACHMENT 2
Executive Summary Form

1. **Project description:**

The proposed project responds to specifications for *Group 2: Demonstration community outside poorest environmental quality regions*. This proposed project called ***Chemehuevi Community Project***, hereafter the Project, will deploy and demonstrate two pre-commercial solar technologies, 50 kW Dense Cell Interconnect solar PV system from Cogenra, 40 kW high-performance solar PV system from Solexel, combined with a 60 kWh/30 kW flow-battery energy storage system (FBESS) to integrate and manage: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities at the demonstration community. The demonstration site is the Chemehuevi Community Center (CCC), which is also the Emergency Response Center in the Chemehuevi Indian Tribe. The integration and deployment of two pre-commercial solar PV technologies along with FBESS permits flexibility in Energy Management System (EMS) optimization while demonstrating the unique characteristics of each technology and their advancement compared to standard commercially available products

2. **Project goals and objectives:**

This Project system architecture targets the reduction of customer demand side peak electricity charges while providing demand response functionality to the utility, and demonstrating two pre-commercial solar PV technologies.

The specific Project goals and objectives include:

1) Install and deploy 50 kilowatt (kW) of Dense Cell Interconnect solar PV technology.
2) Install and deploy 40 kW of high-performance, low-cost, crystalline solar PV.
3) Install and deploy 60 kilowatt hours (kWh)/30 kW zinc-flow BESS.
4) Integration of a demand response capable smart inverter within the stationary FBESS.
5) Integration of energy management software capable of peak reduction, load shifting, demand response, and FBESS to grid delivery.
6) Implementing advanced EMS algorithms and strategies capable of managing energy in response to solar production, FBESS state of charge (SOC), building and utility demand.
7) Working with the Chemehuevi Indian Tribe and Southern California Edison to perform operation and demonstration of a system incorporating solar and load forecasting,energy demands, and demand response, for at least 12 months, while collecting system data.
8) Implement interoperability, control and communication protocols that can be replicated.
9) Validate system operation, quantify electrical demand impacts and emission offsets.
10) Document and make available the knowledge gained, experimental results, and lessons learned to the public and key decision-makers.

The Project's innovation and advancement is based on integration of the team's knowledge, established and pre-commercial technologies, and energy management methods in a novel and advanced architecture. The project partners have significant expertise in energy generation and storage, power conversion, energy management, communication and control deployments. This Project and proposed architecture will maximize the benefits available through advanced strategies for energy management by combining solar energy and flow-battery technologies.

3. **Explanation of how project goals and objectives will be achieved, quantified, and measured:**

The Project employs expertise, knowledge, and deployment skills previously demonstrated by the Project team including demand response, battery energy to grid, and smart control (i.e. peak shaving and load shifting). This project is advancing the science by integrating previously demonstrated functions within an architecture that can be adapted to various site conditions and energy profiles. The pre-commercial generator technologies will be provided by the Project partners (Cogenra and Solexel) and will be coupled with a FBESS provided by the project partner (Primus Power) with an appropriate control system. The advanced energy management strategies will be implemented by UCR in collaboration with OSIsoft. Integrated energy management strategies, control software, and microgrid development have been demonstrated by UC Riverside in their Sustainable Integrated Grid Initiative (SIGI) smart microgrid deployment. This project harnesses the expertise of those at the forefront of: energy generation and storage, energy management, regulation and conditioning, demand response, and microgrids.

4. Project task description:

The individual tasks and brief descriptions are listed below:

Task 1: General Project Tasks – Execute kickoff and status meetings, formation of Tech Advisory Committee, project reporting, permitting, development and commercialization plan.
Task 2: System Architecture – Define and specify energy management software and control algorithms capable of demand response, battery energy to grid, and smart control operations (i.e. peak shaving and load shifting).
Task 3: Solar Integration – Acquire and integrate the two proposed pre-commercial solar technologies totaling 90 kW of on-site generation.
Task 4: Flow-Battery Integration – Acquire and integrate the proposed flow-battery system totaling 60 kWh/ 30 kW of on-site energy storage.
Task 5: Energy Management System – Configure and implement EMS functions based on facility daily energy profile, solar energy production, SOC of flow-battery, and utility requests.
Task 6: System Deployment and Commissioning – Install and deploy system components and architecture at the Chemehuevi India Tribe in SCE territory.
Task 7: System Operation – Operate and demonstrate the system in collaboration with technology partners, facility energy demands, and demand response for at least 12 months.
Task 8: Evaluation of Project Benefits – Report the energy, financial, emissions, and utility benefits resulting from this project.
Task 9: Technology/Knowledge Transfer Activities – Develop a plan to make the knowledge gained, experimental results, and lessons learned publically available.
Task 10: **Production Readiness Plan** – Determine the steps that will lead to the commercialization of the project's results.

5. Agreement management description:

The proposed project is a combined effort lead by UC Riverside with several sub-contractors (project partners) completing specific defined tasks: Cogenra (50 kW solar PV); Solexel (40 kW solar PV); Primus Power (flow-battery energy storage system); and One Cycle Converter (demand response capable inverter). UC Riverside in collaboration with OSIsoft will integrate EMS and control software to manage system components and communicate with utility demand response programs.

UC Riverside will oversee and manage all tasks and financial obligations and ensure deliverables from sub-contractors are met. UC Riverside will coordinate installation at the demonstration site and oversee operational data and system performance. UCR will complete all reporting, validation, and quantification of system results.

ATTACHMENT 3
Fact Sheet Template

Limit the fact sheet to **two** pages. See the formatting requirements in Part III, Section A.

The Issue

California's electricity grid is undergoing significant changes as customers are choosing distributed renewables for their electricity needs, the cost of renewables is dropping, and the continual deployment and improvements of energy efficiency measures. All these developments are crucial for California to meet its AB 32 goals, but they come with a number of challenges such as supply uncertainty, an explosion in the number of customer-generators and changing demand patterns. Along with these challenges there is the continual increase in energy, power, and ramping demands, as a result new solutions will be required for the future electricity grid to continue providing electricity to customers on demand. Energy storage technologies have the potential to increase the reliability of California's energy supply, and the ability to dispatch energy sources. While solar power generation helps California to generate energy with little detriment to the environment, the intermittent nature of these sources requires special attention when connecting them to the grid. Integration of energy storage options could help address these system challenges and balance the development of newer, distributed energy technologies with the continued development of well-established generation technologies. Integration of generation and energy storage within a community requires coordinated energy management strategies between the generation sources, utility, storage and distributed loads.

Project Description

The Chemehuevi Community Project deploys and demonstrates two pre-commercial solar technologies, 50 kW Dense Cell Interconnect solar PV system from Cogenra, 40 kW high-performance solar PV system from Solexel, combined with a 60 kWh/30 kW flow-battery energy storage system (FBESS). This system integration is coordinated through OSISoft's PI Software to integrate and manage: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities at the demonstration community. The demonstration community dedicated to this project consists of a single facility with an average energy consumption 102,000 kWh/year and adjacent buildings. The main facility is the Chemehuevi Community Center (CCC), which is designated as the Emergency Response Center in the Chemehuevi Indian Tribe. The integration and deployment of two pre-commercial solar PV technologies permits optimum flexibility in energy management while demonstrating the unique characteristics of each technology and their advancement compared to standard commercially available products. In addition, the FBESS can meet demand response and energy management requests while critical load at the CCC is being utilized and maintained, minimizing operational impacts to the Community Center.

The project goals include:

- Demonstrate the facility and IOU ratepayer benefits of an EMS integrating advanced PV with BES;
- equip existing community center with 90kW of advanced PV generation and 60kWh of BES;
- integrate DR capabilities within the facility EMS to optimize between PV generation and BES;
- install and deploy system components and architecture at designated Community Center in Southern California Edison (SCE) territory to facilitate continued operation of the facility during power limited events;

- ensure system architecture, components, technology, and participants are commercially viable; and
- validate system operation, quantify electrical demand impacts, quantify emission offsets.

Anticipated Benefits for California
California ratepayers will obtain both short-term and long-term benefits from the Project. Because the project deploys prototype technology in a practical community application ratepayers will see the real benefit of reliable integrated BES and PV technology. The bi-directionality of the technology to be tested also offers to return electricity to the grid during times of peak demand. Publicity on the project promises to raise public awareness of the science and engineering of the EPIC project. Advanced PV couple with energy storage contributes multiple benefits to California's electricity ratepayers by helping to stabilize the grid, improve service reliability, and reduce power outages. Community based PV coupled BES can offset the need to purchase and install new generation, as well as reduce the use of highly polluting peaking power plants during periods of high demand. The proposed Energy Management System aids the integration of large amounts of variable renewable energy, helping to meet California's aggressive renewable energy goals.

Ratepayers are most sensitive to outages. Currently, utilities must invest in generation infrastructure capable of handling peak demand. The potential for electricity to be stored off peak and returned to the grid during peak demand creates an opportunity for utilities (and ratepayers) to reduce capital investment in new generation and make the most of existing equipment. Moreover, bi-directional storage distributes reservoirs of power widely over many locations, reducing strain on transformers at key junctions. Distributed storage, rather than reliance on fewer vulnerable connections, reinforces the grid's resilience and helps prevent transformer fires and destruction of infrastructure. Ratepayers should know, however, that technologies to save money and make the grid more reliable cannot be introduced without rigorous testing in a safe, controlled environment. This project offers carefully controlled investigation and demonstration of a new idea to help power the community center and give back electricity when ratepayers need it the most.

Project Specifics
Contractor: University of California, Riverside.
Partners: OSISoft, Cogenra Solar, Solexel, Primus Energy, Chemehuevi Indian Tribe
Amount: $2,588,906
Co-funding: $706,698 from OSISoft, Cogenra Solar, Solexel, Primus Energy, and Chemehuevi Indian Tribe.
Term: July 2015 to July 2018

Project Narrative

1. Technical Merit and Need

1. a. Goals, objectives, technological and scientific advancement, and innovation.

The proposed project responds to specifications for Group 2: Demonstration community outside the poorest environmental quality regions. This proposed project, called Demonstration of community scale low cost highly efficient PV and energy management system at the Chemehuevi Community Center (CCC), hereafter 'the Project', will deploy a 50 kW high efficiency solar PV system (Cogenra Solar), a 40 kW high-performance solar PV system (Solexel), and a 60 kWh/30 kW flow-battery energy storage system (FBESS). By integrating these components, we will manage on-site energy through various techniques, including:: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities. The demonstration community chosen as the site for the Project consists of a main facility with an average energy consumption 102,000 kWh/year including three adjacent buildings with a combined average consumption of 46,569 kWh/year. The main facility is the Chemehuevi Community Center (CCC), which is designated as the Emergency Response Center in the Chemehuevi Indian Tribe.

This proposed community scale generation project thoughtfully integrates advanced pre-commercial PV and battery energy storage providing benefits to the community, utility, and ratepayers. The components described above are carefully chosen to optimize flexibility in energy management while demonstrating the unique characteristics of each technology and their advancement compared to standard commercially available products. In addition, the FBESS can meet demand response and energy management requests while critical load at the CCC is being utilized and maintained, minimizing operational impacts to the Community Center. The specific Project addresses the eight required project goals and objectives as follows:

1) The demonstration and deployment of pre-commercial PV generation and battery energy storage (BES) technologies.
2) The enactment of innovative energy management strategies including intermittent production, electric energy storage, targeted energy efficiency, demand management, and power interruptions.
3) The deployment of community scale advanced PV generation and integrated BES strategies will successfully reduce peak energy demands, reduce peak power demand, and demand fluctuations. PV generation will offset daily peak energy and peak power demand during production hours while BES management will offset additional energy and power demands.
4) The project will produce technical and economic performance data on PV generation innovative BES integration strategies. The documentation will include installation issues, operational constraints, operational performance, and impact on utility bills within the community.
5) The challenges and barriers to deployment of community scale PV generation and innovative BES management strategies will be documented and presented. This will include integration with existing infrastructure, community financial and operational support, and regulatory collaboration.
6) The optimal balance of generation resource and BES to reduce peak power and manage daily energy loads will be implemented with performance monitoring.
7) Identification of the energy management strategies that provide the highest value with minimal negative impact. This project will develop and implement the best value between peak demand and daily community energy consumption.

8) The project will provide, utility DR controlled dispatchable power to minimize the daily demand variations of the community and compensate for local variations outside the community.

1. b. Technological advancement and breakthroughs that overcome barriers to achieving the state's statutory energy goals.

California continues to lead the nation in the adoption of renewable generation technologies coupled with pollution reduction. The continued deployment of renewable and especially solar photovoltaic electricity places new demands on the grid both spatially and temporally. The diurnal state energy demand is projected to have potential excess generation midday due to solar generation resources (Figure 1), the so-called "duck curve". This project currently limits the market participation of the proposed energy management strategies to DR applications. This Project is not initially intended to participate in frequency regulation or wholesale markets, but we will design the system architecture to accommodate more advanced strategies. The Project partners will deploy the technology such that future participation in frequency regulation and wholesale markets is feasible within the proposed system architecture.

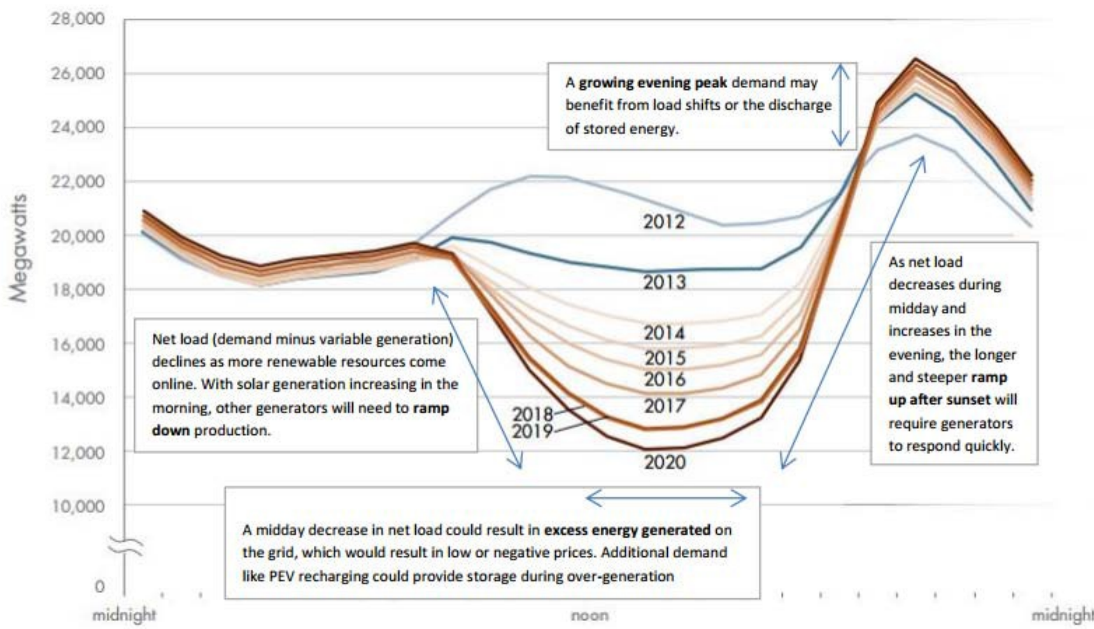

Figure 1. CPUC and CAISO projections of solar generation impacts on California electrical system [1].

The state's energy goals are closely coupled with emissions reductions. The deployment of renewables, low carbon generation, and alternative fuels in a distributed network leads to significant challenges with energy management, dispatching, regulation, and reliability. This Project addresses and facilitates the deployment of renewables and low carbon energy sources by moderating and controlling energy flows with direct utility communication. The Project is scalable to fit community uses on the meter side of the grid as well as within the distribution network.

1. c. Current status of the relevant technology and scientific knowledge, and how the proposed project will advance current technology and scientific knowledge.

The Project employs expertise, knowledge, and deployment skills previously demonstrated by the Project team. Demand response, battery energy to grid, and smart control (i.e. peak shaving and load shifting) have all been previously demonstrated in specific tailored applications. This project is advancing the science by integrating previously demonstrated functions within a microgrid architecture that can be adapted to various site conditions and energy profiles. The pre-commercial generator technologies will be provided by the Project partners (Cogenra and Solexel) and will be coupled with a FBESS provided by the project partners (Primus Power) with appropriate power control system. The advanced energy management strategies will be implemented by UCR in collaboration with OSIsoft. The two pre-commercial solar technologies are a new advancement in terms of their energy efficiency, cost-effectiveness and system integration. Integrated energy management strategies, control software, and microgrid development have been demonstrated by UC Riverside in their Sustainable Integrated Grid Initiative (SIGI) smart microgrid deployment.

This project harnesses the expertise of those at the forefront of: energy generation, energy storage, energy management, power regulation and conditioning, demand response, and microgrids. Integrated Energy Management System (EMS) strategies, control software, and energy management have been demonstrated by UC Riverside (Figure 2) in their Sustainable Integrated Grid Initiative (SIGI, see http://www.cert.ucr.edu/sigi) smart microgrid deployment. BES systems have also been created and deployed by the project partners (Primus Energy and OSISoft) with appropriate Battery Management Systems (BMS) and system control.

1. d. Demonstrates all the following:

The two advanced PV systems have improved efficiency and improved cost effectiveness.

***Cogenra* –** Cogenra's Slate modules incorporate the break-through Dense Cell Interconnect (DCI) technology, which rewires the PV modules by eliminating the bus-ribbons, solder-joints in PV cells and inter-cell gaps. This is a significant innovation that will change the way solar panels are built in the coming years. Cogenra's Slate PV modules are pre-commercial and have recently completed all the requirements for IEC certification. With a conversion efficiency of 18%, are a cost-effective solution.

***Solexel* –** Solexel's goals are to develop innovative residential BIPV products and achieve <$2/W by 2017. Solexel produces the Smart Cell technology with integrated MPPT, embedded shade management and integrated ON/OFF capability and to demonstrate an estimated 25+ year field life expectancy. It's proprietary technology includes patented flexible, monocrystalline silicon high efficiency solar cells. This technology enables a high voltage cell design to reduce cell and BOS costs and flexible cell packaging with design leveraged to multiple products. Solexel also maximizes power harvest with cell level MPPT and shade management.

Regarding the implementation of additional energy efficiency measures to improve community energy use, the Chemehuevi community has planned improvements include lighting and HVAC energy reductions. Additional load monitoring will identify future energy improvements that the Chemehuevi Tribe can consider in the near future.

The combined yearly energy consumption for the Chemehuevi Community identified for this project is 148,678 kWh/year, and consists of a main facility (Chemehuevi Community Center) with an average energy consumption 102,000 kWh/year and three adjacent smaller buildings with a combined average consumption of 46,569 kWh/year. The proposed generation capacity, from the two pre-commercial and PV technologies is 90 kW, and has the capacity to provide the majority of the energy needed by the Community, producing more than 150,000kWh/year. The peak load demand from the CCC is 48 kW. The FBES that will be integrated in this project has a power rating and energy storage capacity of 30kW/60kWh. Therefore, the FBES will be able to reduce power demand by about two thirds when discharging at its rated value of 30 kW at any given time. It is anticipated that with the implementation of energy management smart strategies, the infrastructure and equipment rating will allow us to satisfy the requirement of reducing beyond 10% the difference between the community's average daily peak power demand and the average daily power demand placed on the grid by the community. Furthermore, by discharging the flow battery during peak time by implementing algorithms designed to lower the KW demand, we can achieve a greater than 10 percent decrease in the daily average energy demand during peak times.

1. e. Need for EPIC funding, including an explanation of why the proposed work is not adequately supported by competitive or regulated markets.

Deployments of utility integrated PV and BES applications have been successfully demonstrated in proof of concept and field demonstrations. Wide scale deployments have failed to materialize due to numerous technology, social, and political barriers. Commercially viable products have failed to materialize with existing barriers dampening market interest. The current timing and existing conditions of policy, standards, and technology are ideal for full development and commercialization of PV and BES enabling products. The Project will leverage EPIC funding to assemble the key participants and partners to integrate, deploy, validate, and quantify a commercially viable energy management system.

1. f. Degree to which the proposed work is technically feasible and achievable.

The Project does not currently have an interconnection application in process with the utility. The application will be submitted upon approval and commencement of the project. The planned community energy efficiency measures include load shifting and peak demand reduction goals. The advanced PV generation will reduce daily energy demand while integrated BES will manage peak demand. The team will deploy and integrate these strategies based on previous demonstrated experience as detailed below.

The proposed project has a technical foundation in prior and ongoing projects completed by UC Riverside and project partners. As part of the SIGI smart grid system, UC Riverside has deployed 4 MW of solar renewable generation, 2 MWh of battery storage, 29 passenger EV Trolley bus, and 20 level 2 EV chargers. This SIGI system, shown in Figure 2, encompasses the efforts being demonstrated in the proposed Project for system integration, energy monitoring, energy management, and system control. SIGI serves as a research testbed which can spin off different microgrid architectures and applications such as the one specified in the proposed Project.

OSIsoft provides energy historian software with energy management functionality and control [2]. OSIsoft's PI software package provides a secure data and communications interface for Demand Response and energy management controls. UCR will integrate existing microgrid energy management and control functions within the PI Software environment. OSIsoft and UCR will collectively deploy a utility integrated energy management and control system.

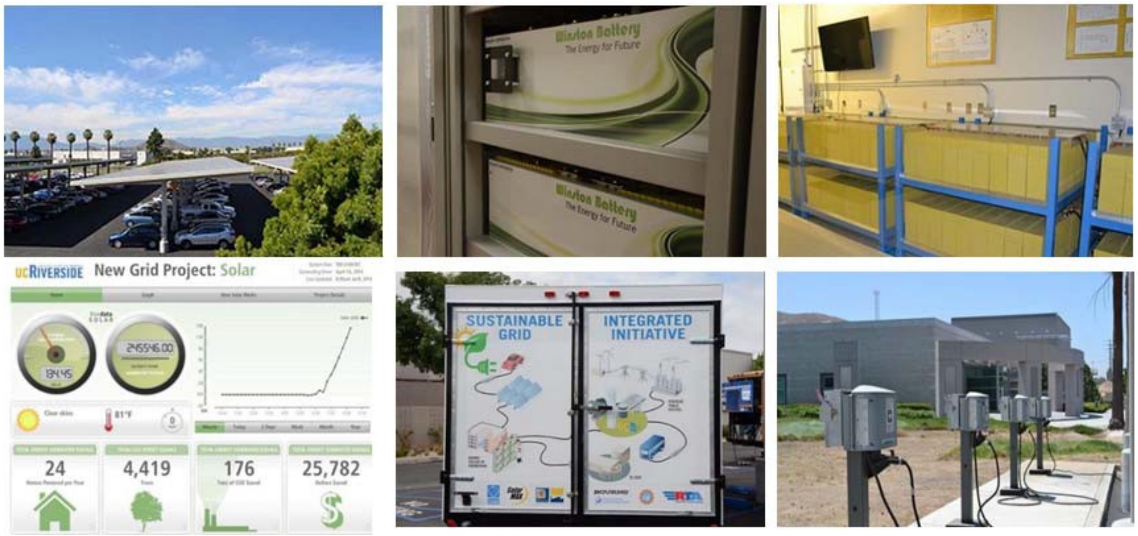

Figure 2. UC Riverside's SIGI microgrid components.

The effort and expertise of the project partners will be combined to create an integrated energy system capable of PV generation coupled with BES while maintaining flexibility to implement a wide variety of energy management strategies. The project participants have previously demonstrated technological feasibility in their respective fields of expertise. This Project facilitates the integration of multiple parties' expertise into a single community scale microgrid implementation. These energy management strategies will be demonstrated at the community center facility with 60kWh BES and 90kW of advanced PV for a period of 12 months with integrated monitoring, control, and data collection.

1. g. Measurement and verification plan to quantify energy savings and other benefits specified in this application.

This project will integrate OSIsoft's PI software historian package [3]. OSIsoft's PI Software is a well established energy management suite for monitoring and database storage. This Project is essentially establishing an energy storage microgrid optimized for community operations. To maximize the Project's energy performance, numerous measurements will be integrated within the PI software database, namely:

- facility main supply power voltage, current;
- PV real time energy generation (current, voltage);
- BES real time SOC, current, voltage;
- DR received requests; and
- System management command status.

The measured data from these sources will be utilized for real time energy management algorithms and stored with the systems operational state in the PI Software historian database.

The system operational data will be compiled monthly and reviewed for performance and validation. The decision tree commands affiliated with system charge/discharge operation and power magnitude will be verified for specific events relative to DR and energy management decisions. The project reporting at the conclusion of the demonstration will quantify the benefits of project deployment and determine fractional benefits attributed to the various operational states. Special analysis and attention will be given to determining if the system improved the sites power reliability and resiliency. System energy management priority will be given to maintaining site power to perform daily operations.

2. Technical Approach

2. a. Technique, approach, and methods to be used in performing the work described in the Scope of Work and highlights of outstanding features.

The Project tasks and system architecture allows for parallel tasks to be completed simultaneously. The project partners will procure and prepare individual components while UCR defines deployment requirements and system communication, monitoring, control architecture and component configuration. Additionally, UCR will specify the data communication and control specifications in coordination with each project partner. UCR will distribute power and data component connections at the transition points from each module to the overall system.

Each project partner will be responsible for modular tasks with deliverables that allow for the subsequent integration of system components. The project partners are only interdependent upon the system integration task. Each project partner will be held to a delivery and integration schedule for providing the specific system component conforming to integration requirements for power, data communications, and control.

The technical approach consists of 3 major project components:

1) 90 kWh advanced PV deployment;
2) 60 kWh BES with integrated BMS and DR inverter;
3) Power Management System integrated with OSIsoft PI Software database and control;

The PV and BES system components will be developed to function autonomously under the control of the Power Management System. While the two systems will be interdependent for determination of the control state, the PV and BES can function independently.

Primus' core technology is the EnergyCell, a modular 30kW / 60kWh flow battery that departs from conventional deep-cycling battery technology to deliver class leading power density and low total cost of ownership. The EnergyCell's novel design addresses many of the limitations plaguing both emerging and conventional grid-scale energy storage products. The EnergyCell is differentiated by the following characteristics:

- Safety-by-design – aqueous electrolyte is non-flammable and battery has a multi-layer safety system
- Low total cost of ownership – nearly 1/3 less upfront cost than other available technologies coupled with low maintenance cost and no required cell replacement over 20-year life of deep-discharges
- Small footprint – more than 5x competing technologies, is enabled through metal electrodes, which can be run at current densities nearing 200mA/cm2
- Long service lifetime – 20 years and 15,000, 100% depth of discharge cycle capability due to the robustness of the metal electrode design and elimination of key failure modes such as life-limiting membrane separators
- Modular and mobile design for incremental deployment and relocation enabling the asset owner flexibility during long asset life

The EnergyCell architecture is mobile and modular, allowing for scalable construction. The EnergyCell can regularly discharge all of its energy capacity without significantly reducing the capacity of the battery. Lithium-ion will need replacement after 2,000-3,000 cycles compared to

Primus, which has tested its electrodes through 15,000 cycles without need for replacement. The EnergyCell is built around an aqueous electrolyte and not susceptible to thermal runaway.

Relative to system control and the EMS, the EMS uses standard control system techniques. The lowest level control function (Level One) is called the Modular Controller (MOD) and executes in the protective relays associated with each DER/*Battery and the PCC. The middle level (Level Two) executes in a CyberSecure Synchrophasor Platf*orm called the CSSP and is called Model Predictive Control (MPC). It runs in one of the virtual machines (VMs) running inside the CSSP box. This is a fully redundant system meeting NERC CIP standards for cybersecurity mainly being able to be patched without loss of data or control functionality. The third level also executes a separate VM inside CSSP and handles communications with the power markets and provides constraints for the Level two controller. This is called the Optimizing Controller (OC). The OSIsoft PI system hierarchy is shown in Figure 3.

The entire system is executed in off the shelf substation hardened computers and protective relays purchased from SEL. These have no rotating memory and are guaranteed for ten years. These modern low cost digital devices have sufficient computing power to provide real time solutions required for optimal control of the system. This includes the extensive use of real time feedback signals from measurements in the microgrid and data from external markets.

Our microgrid controller meets the IEEE 1547.4 and IEEE 2030.7 standards for microgrids. This includes a state measurement system for the microgrid.

The EMS consists of the hardware components shown in the adjacent Figure 3. The upper right shows the heart of the microgrid control system (MGCS) consisting of redundant SEL 3355 substation hardened computers. These are powered by independent backup Uninterruptable Power Supplies (UPS). The Distributed Energy Resources (DERs), batteries, and the PCC use SEL relays to affect real time control including protection functions for each device. Communications between the devices is either secure wireless or over fiber optic links using Infiniband technology. This technology provides deterministic time latency over the network that will improve the control system response.

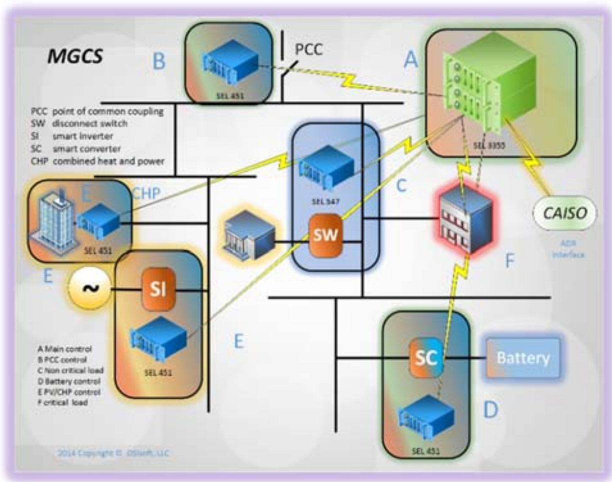

Figure 3. OSIsoft EMS monitoring and control software.

Our approach is in sharp contrast to traditional power system controls that are based primarily on open-loop control. For example a cap-bank will connect and disconnect to the grid based on a daily schedule based on time of day. The schedule is determined by planning studies and is rarely changed until excessive faults or customer complaints cause the problem to be revisited. Using time synchronized measurements for feedback control is innovative and necessary to control the microgrid under intermittent internal energy generation, large variations in load and demand response from the connected grid.

The critical success factor in any control system is continuous on-line accurate and reliable measurements. With the availability of accurate and reliable time synchronized measurement devices that include voltage, frequency, and angle, advanced control systems can be implemented for in the power industry. New measurement devices called PMUs (phasor measurement units) will be available in both stand-a-lone and embedded in protective relays. A typical PMU as shown in the inset (Arbiter 1133a) can measure 684 variables including the harmonics. The key measurements are the phasors for both current and voltage. These provide a complete measurement of the “state” of the system. The PI System provides the means to display, calculate data in real time and archive the data while delivering streaming data to hundreds of clients.

An example of one of the protective relays that could be used in the ESS is shown in Figure 4 on the right. The proposed system will use PMU measurements from the protective relays installed at each DER and energy storage device in the microgrid. A number of manufactures sell these including: GE, AlstomGrid, ABB and Siemens; however the most common and lowest cost relays are manufactured by SEL (Schweitzer Engineering Laboratories) cost from $1000 to $5000 each and are guaranteed for at least ten years.

Figure 4. Integrated PMU embedded in protective relay.

The first step in the microgrid controller development is to collect all available existing data associated with the Project components: facility demand, PV generation, BES operational status, BES battery status, current and forecasted grid demand. The OSIsoft PI system can read these data continuously into the PI server as time series datasteams in near real time.

Control of microgrid with PV and BES integration can be considerably more difficult than controlling a large high voltage grid. There are several main reasons affecting microgrid controllability as addressed in section 5 of the IEEE 1547.4 standards for microgrids.

The main issues are:

- lack of sufficient inertia to dampen disturbances in the grid either in the form of load changes or internal generation;
- injection of harmonics into the grid by PV inverters;
- phase imbalance; and
- small signal stability induced by the interaction of the local generators and large electric motors in the microgrid and protection.

The basic control system approach is to use the low order models developed for oscillation mitigation control directly for regulation control using the model predictive control technology, commonly known as MPC. The concept is relatively simple: solve a finite time constrained optimization problem from time t=0 to some finite time=N where N in this case could be one minute. The optimal controls are computed over the entire finite time range and applied at time t=0. Before the next time interval, t=1, the entire solution is recomputed and the first control command is applied again. Basically a moving window, the only the first step in the control trajectory applied and then the entire problem is resolved before the next time step. In this case the time step will be one second.

The most important aspect of the MPC approach to level two control is the ability to factor in constraints and consideration of the future short term time horizon. The main constraints that will be used in the EMS are: (a) limitation on real and reactive power generation from each of the system components, (b) constraints on the BES device maximum power delivered and it rate of change, (c) constraints on the generation from the PV systems, (d) facility power and electrical demand conditions. The constraints vary over time and are specified by the Level three controller, the OC.

The third level optimizer requires a network model. The following network models are potential options: ETAP, openDSS, Grid-LabD, PowerFactory, Power Analytics, Synergee, and ISM. The openDSS and Grid-LabD are free from EPRI and the DOE respectively. The others are commercial grade software packages. Several of the above mentioned software only consider single balanced phase simulation (positive sequence) and therefore are not suitable for use in microgrid studies according to the IEEE 1547.4 standard.

The three levels of the EMS control will be implemented in a sub-station hardened rack mounted PC. The system will be 64 bit hardware and software and will run Windows 2012 64 bit Operating System. There will be multiple Virtual Machines (VMs) running in these computers. The control functions will be developed and tested using the validated model of the microgrid on the simulator and then switched into the actual grid.

The Project is scheduled for 37 months with the initial 18 months being system specification and system integration. System deployment will occur in months 13-18. Months 17-29 will consist of system operation with the final eight months dedicated to documentation and reporting.

2. b. How tasks will be executed and coordinated with various participants and team members.

Project team members will participate in a kickoff meeting and summarize their respective tasks, schedules and deliverables. The project manager will coordinate with key personnel from each team and coordinate configuration and integration tasks. The project manager will identify and oversee deployment tasks and subtasks in coordination with respective key personnel.

A Technical Advisory Committee will be assembled consisting of key stakeholders as outlined in the Scope of Work. The TAC will be provided with Test Plans and system architecture design. The coordination of participants and team members will be provided to the TAC for input and consideration.

Commissioning and validation of system components will be overseen by the project manager. The Project participants will be provided a detailed schedule of relevant tasks and sub tasks with specific deliverables, milestones, and deployments. UC Riverside personnel and staff will coordinate with Project partners as necessary to ensure system integration and deployment remains on schedule and on budget.

During development, integration, and deployment UCR will hold a weekly meeting (webinar) to discuss individual task progress and task coordination. The weekly meeting will be required for participants of active tasks that involve multiple organizations.

2. c. Factors critical for success, in addition to risks, barriers, and limitations and the plan to address them.

The Project has a very high chance for success due to the team's previous demonstrations and the availability of components being integrated. Most of the risks and barriers would result from individual components becoming unavailable due to unforeseen circumstances. The countermeasure for this situation would be a comparable replacement. This type of situation can be addressed promptly and would potentially require approval from the funding agency to change proposed partners and/or equipment. Additionally, the deployment location could become unavailable due to unforeseen circumstances. This situation would require relocation of the deployment site and is very feasible due to the existing relationships of the project team.

A critical factor for success includes the detailed planning of the data and communication architecture integrating the system components. The fidelity and applicability of the control functions will contribute to the overall system benefits and effectiveness. Long term component reliability is often a concern regarding new technology deployments. This project will be operated with a very collaborative partner and contain automatic notification of system shutdown and/or failure. The Project team will quickly respond to system interruptions.

2. d. How the knowledge gained, experimental results, and lessons learned will be made available to the public and key decision-makers.

The proposed project prime recipient is a California public university held to public dissemination requirements and guidelines. All non-proprietary project information and publications will be made available on University-managed websites and publication databases. Additionally, key research findings and analysis results will be compiled and submitted to relevant workshops, journals, periodicals, and publications. Access to the Project's data, analysis methods, performance, and results will be made available upon request. Additionally, the final report will summarize all project Tasks and be made available online. Finally, the technology development, integration, and operational strategies will be made available to appropriate decision-makers and commercialization teams for commercial deployment.

2. e. Describe what historic energy consumption and generation data for the community is available to the community, and how data not available through the local utility will be collected during the project in accordance with the eligibility requirements.

The Community Center is a current utility customer with historical meter usage and energy demand. Existing meter utility records will be utilized for historical peak and energy profiles. Upon commencement of the project additional metering and data recording will be implemented to monitor and record facility and community energy use. The additional monitoring will provide detailed daily usage for 12 months prior to system deployment.

2. f. Discuss how the deployed technologies and innovative strategies will be used by the community to meet the eligibility criteria.

The integrated PV and BES will provide methods to control peak demand in conjunction with daily energy use. Daily PV generation will offset site energy use while utilizing any excess available for BES functions. PV energy production and BES energy will also be available for utility initiated DR functions.

3. Impacts and Benefits for California IOU Ratepayers

3. a. How the proposed project will benefit California Investor-Owned Utility (IOU) ratepayers with respect to the EPIC goals of <u>greater reliability</u>, <u>lower costs,</u> and/or <u>increased safety</u>.

California ratepayers will obtain both short-term and long-term benefits from the Project. Because the project deploys prototype technology in a practical community application ratepayers will see the real benefit of reliable integrated BES and PV technology. The bi-directionality of the technology to be tested also offers to return electricity to the grid during times of peak demand. Publicity on the project promises to raise public awareness of the science and engineering of the EPIC project. Knowing that they contributed to California's leadership in addressing the challenge of powering a huge port to the world may be an immediate source of pride for ratepayers.

However, much more important in the long term for ratepayers is establishing the economic and practical feasibility of the system, proving the reliability of components from manufacturers in California, and reducing risk for future investment. The economies of new technology reward large-scale adoption because per-unit costs typically fall as production and sales increase. Unlike specialty products with limited application, proven and widely adopted technologies result in lower costs for later installations, reducing ratepayer electric bills. For example, early compact fluorescent light bulbs were much more expensive than today thanks to an established market and economies of scale.

Ratepayers are most sensitive to outages. Currently, utilities must invest in generation infrastructure capable of handling peak demand. The potential for electricity to be stored off peak and returned to the grid during peak demand creates an opportunity for utilities (and ratepayers) to reduce capital investment in new generation and make the most of existing equipment. Moreover, bi-directional storage distributes reservoirs of power widely over many locations, reducing strain on transformers at key junctions. Distributed storage, rather than reliance on fewer vulnerable connections, reinforces the grid's resilience and helps prevent transformer fires and destruction of infrastructure. Ratepayers should know, however, that technologies to save money and make the grid more reliable cannot be introduced without rigorous testing in a safe, controlled environment. This project offers carefully controlled investigation and demonstration of a new idea to help power the community center and give back electricity when ratepayers need it the most.

3.b. Quantitative estimates of potential benefits for California IOU electricity ratepayers.
This project will benefit California IOU electricity ratepayers by lowering overall cost of supply electricity and reduced GHG emissions. The detailed potential economic benefits come from 8 different revenue streams: peak demand charge reduction, energy cost reduction, transmission and distribution upgrades deferral, improved electric service reliability, improved electric service power quality, ancillary services, voltage support, and electric supply capacity through demand response. The total tangible economic benefit of this project is estimated at $1,595,486. In total this project has 8 non-overlapping revenue streams which are listed in the table below. The detailed methodology of the calculations follows.

Benefit Type	Amount
Peak demand charge reduction	$107,268
Energy Cost Reduction	$507,335
Transmission and distribution upgrades deferral	$109,920
Improved electric service reliability	$156,480
Ancillary services	$380,403
Improved electric service power quality	$156,480
Voltage support	$64,000

Electric supply capacity through demand response	$113,600
Total Economic Benefits	$1,595,486

3. c. Timeframe, assumptions, and calculations serving as the basis for the estimated benefits, and explains their reasonableness.

The timeframe for analysis is 15 years which is the estimated economic life of flow battery and solar PV systems. The assumptions for the calculations are as following: 1) The size of the BES installed is 60 kWh with 30 kW charging rate, 2) The size of the Dense Cell Interconnect solar PV system is 50 kW with an energy conversion efficiency of 18% and the size of the high-performance solar PV system is 40 kW with an energy conversion efficiency of 21%. 3) The average annual energy consumption of the facility is about 102,000 kWh 4) The solar and energy storage system are under net energy metering system with a feed-in tariff and the facility is under Time-of-Use General Services. The demand charge is 7.23/kW/Month and the average energy charge is $0.13/KWh which is calculated based on weighted average of energy charge in different season and on/off peak scenarios. 5) The capacity factor of solar system in California is estimated at 33%.

The peak demand charge reduction benefits for 15 years is estimated at (30 kW + 50 kW x 0.18 + 30 kW x 0.21) x 7.23/kW/Month x 12 Month/Year x 15 Year = $107,268. The energy savings and energy cost reductions for 15 years is estimated at 8760 hours/year x 33% x 90 kWh x 15 years x $0.13/kWh = $507,335. The ancillary services benefit is estimated with regulation prices forecast from SP 15 generation hub in California based on historical price information. The transmission and distribution upgrades deferral, improvement in electric service reliability, voltage profile, and power quality benefits are estimated based on Sandia National Laboratory report 2010-0815. At last, the electric supply capacity through demand response benefit is estimated based on LA basin resource adequacy price forecast.

3. d. Impacted market segments in California, including size and penetration or deployment rates, with underlying assumptions.

The pilot demonstration project and technologies developed will impact the following market segments: Advanced PV, Energy Storage, Demand Response and Grid Ancillary Services.

PV Generation: This project will be demonstrated in Southern California Edison (SCE) service territory with collaboration from SCE's distribution department. The PV generation technology with smart inverters demonstrated in this project has huge deployment potential in the next 10 years.

Energy Storage: The stationary energy storage device used for peak shaving and that satisfy the smart charging needs critical facilitis be replicated for all customer Behind-The-Meter storage system as mandated in AB 2514.

Demand Response Service: In this project, we plan to control energy storage charging to provide demand response service. The technology could reach all demand response customers that have energy storage system in California. For example, currently the demand response potential in SCE service territory is about 1,000 MW.

Grid Ancillary Services – With an estimated in state market of ISO based ancillary service of 2.9 GW, the energy storage system installation could supply 1,325 MW of ancillary service capacity with existing energy storage deployment plan in California (46% of A/S market).

3. e. Qualitative and intangible benefits to California IOU electricity ratepayers, including timeframe and assumptions.

This project will results in the following intangible benefits to California IOU electricity ratepayers:

Cleaner Air from fewer gasoline miles and power plant emissions leading to lowered health impacts. (see, e.g., http://www.lung.org/assets/documents/publications/solddc-chapters/air-quality.pdf).

Lowered wholesale cost of electricity due to reduced spending by CAISO on Ancillary Services.

Safety: Reduction in use of flammable fossil fuels and related toxic chemicals.

Technology Transfer: Due to the high-visibility site, IOUs will have a great opportunity to learn from the solar PV with smart invertor and energy storage integration and demonstration experience in this project.

3. f. Cost-Benefit Analysis.

The project equipment includes battery monitoring and control hardware, inverter, communication and monitoring software, energy storage system and installation of advanced PV generation. The total project equipment and material cost is estimated at $539,000. Total project benefit from eight non-overlapping revenue streams is estimated at $1,595,486. The benefit to cost ratio of the proposed project well exceeds 100%. The successful demonstration of advanced PV generation, BES and demand response capability paves the way for future integrated community deployments. If we assume that the net benefit per kW of integrated BES ($243/kW) could be extrapolated to one percent of ratepayers.

4. Team Qualifications, Capabilities and Resources

4. a. Describe the organizational structure of the applicant and the project team. Include an organizational chart that illustrates the structure.

The proposed project is a combined effort lead by UC Riverside with several sub-contractors (project partners) completing specific defined tasks: Cogenra will provide a 50 kW solar PV system; Solexel will provide a 40 kW solar PV system; Primus Power will supply flow-battery energy storage system; and One Cycle Converter will supply and facilitate integration of a demand response capable inverter. UC Riverside in collaboration with OSI Soft will integrate energy management and control software to manage system components and communicate with utility demand response programs.

UC Riverside will oversee and manage all tasks and financial obligations and ensure deliverables from sub-contractors are met. UC Riverside will coordinate installation at the demonstration site and oversee operational data and system performance. UCR will complete all reporting, validation, and quantification of system results.

The organization chart for the project team is shown in Figure 5 below.

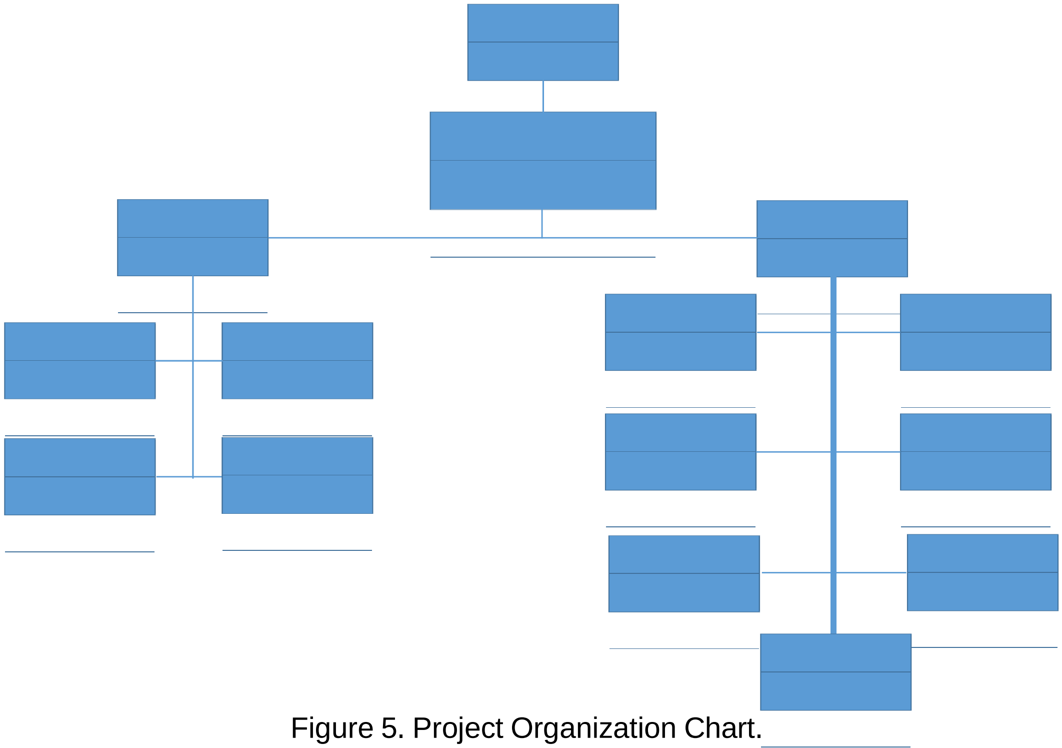

Figure 5. Project Organization Chart.

4. b. Identify key team members, including the project manager and principal investigator. Include this information in Attachment 5, Project Team Form.
A brief description of each of the key members of the project team is given below in Section 4.3.

4. c. Summarize the qualifications, experience, capabilities, and credentials of the key team members. This information is included in Attachment 5, Project Team Form.
Dr. Alfredo Martinez-Morales – Managing Director, Southern California Research Initiative on Solar Energy (SC-RISE). Ph.D. UCR. Nine years professional experience in energy systems, battery and solar materials research.

Dr. Sadrul Ula – Managing Director and Research Faculty, Winston Chung Global Energy Center, Bourns College of Engineering, University of California – Riverside, Ph.D. University of Leeds, England, Post-Doctoral MIT. Forty years of professional experience in theory and practice of electrical power and energy engineering. Principal Investigator for the project.

Mike Todd, PE – Principal Development Engineer, UCR; B.S. Electrical Engineering, UCR. Twenty two years of professional experience in intelligent transportation, electric vehicle and electric grid.

Dr. Matthew Barth – Director, College of Engineering - Center for Environmental Research and Technology (CE-CERT), and Yeager Professor of Electrical Engineering at UCR. Ph.D. UC Santa Barbara. Over twenty eight years of experience in transportation and control system research and applications.

Dr. Nanpeng Yu – Assistant Professor, UC Riverside. Ph.D. Iowa State University. Over 10 years of professional experience in power engineering research, development and project management in academia and utility industry.

Brendan Harney – Brendan Harney, Sr Manager of Business Development, leads commercial and industrial business development and marketing activity for Primus Power. Prior to Primus, Brendan led commercial market development at SolarCity. Brendan has a Masters from Georgetown University's School of Foreign Service and an MBA from Cambridge University.

Dr. Chuck Wells – Industry Principal, OSIsoft. Ph.D. Washington University. Dr. Wells for the past 2.5 years worked exclusively on the microgrid controller at UCSD, where he is a Visiting Scholar. Dr. Wells is the holder of six US Patents in Microgrid Control technology. Dr. Wells has a PhD in Electrical Engineering, MS Chemical Engineering and BS in Chemical Engineering. Dr. Wells Registered Professional Engineer in Chemical Engineering and Control System Engineering in State of California.

Ratson Morad – Cogenra, Mr. Ratson Morad brings over 20 years experience building start-up companies and global organizations in the high tech sector, predominantly for photovoltaic and semiconductor equipment. Mr. Morad earned his Master of Science degree in Mechanical Engineering from Ben Gurion University in Israel and completed his Business Management studies at the Technion, Israel Institute of Technology.

Sam Cowley – Solexel, Mr. Cowley has worked in solar for nine years, performing many field installations of new technologies. These include concentrated photovoltaic systems, building integrated systems and specialized products for customers. He has managed field teams and signed off on multiple demonstration and commercial projects.

4. d. Explain how the various tasks will be managed and coordinated, and how the project manager's technical expertise will support the effective management and coordination of all projects in the application.

Mike Todd will coordinate tasks, develop and manage project timelines, to include component assembly, testing, and operation, as well as site development and deployment. Mr. Todd's demonstrated project management experience at UCR CE-CERT will be key in coordinating the activities among the research team.

Task 1: General Project Tasks – Execute kickoff and status meetings, formation of Technical Advisory Committee, project reporting, permitting, development and commercialization plan.
Task 2: System Architecture – Define and specify energy management software and control algorithms capable of demand response, battery energy to grid, and smart control operations (i.e. peak shaving and load shifting).
Task 3: Solar Integration – Acquire and integrate the two proposed solar technologies totaling 90 kW of on-site generation.
Task 4: Flow-Battery Integration – Acquire and integrate the proposed flow-battery system totaling 60 kWh/ 30 kW of on-site energy storage.
Task 5: Energy Management System – Configure and implement energy management functions based on facility daily energy profile, solar energy production, SOC of flow-battery, and utility requests.
Task 6: System Deployment and Commissioning – Install and deploy system components and architecture at the Chemehuevi India Tribe in SCE territory.
Task 7: System Operation – Operate and demonstrate the system in collaboration with technology partners, facility energy demands, and utility demand response for at least 12 months.
Task 8: Evaluation of Project Benefits – Report the energy, financial, emissions, and utility benefits resulting from this project.

Task 9: Technology/Knowledge Transfer Activities – Develop a plan to make the knowledge gained, experimental results, and lessons learned publically available.
Task 10: Production Readiness Plan – Determine the steps that will lead to the commercialization of the project's results.

4. e. Describe the facilities, infrastructure, and resources available to the team.
With funding from South Coast Air Quality Management District (SCAQMD) the UCR team has successfully developed a facility with 2.2 MWh Lithium battery, 4 MW solar PV, one electric trolley, one level 3 charger and multiple level 2 chargers. 500 kWh of the battery is on a mobile trailer. This UCR testbed along with all other resources of this major research university are available to this proposed project for testing and evaluation of all system components and software protocols.

Primus Power is a private, California-based company, that has designed, built, tested, and is deploying a low-cost, utility-grade electrical energy storage solution. Primus' EnergyCell is a safe and reliable flow battery that economically serves megawatt-scale storage applications. Primus' EnergyCell technology has been rigorously tested by leading research institutions and energy technology leaders. Tests with Sandia National Laboratory validated high energy efficiency (70-73%) at discharge durations ranging from 1 to 6 hours, rapid (<1 sec) and accurate response to step changes in charge/discharge commands, and the ability to deliver 150% of nameplate power for an extended period. Bosch, Raytheon, Puget Sound Energy, Modesto Irrigation District, SK Holdings (Korea's third largest conglomerate), have all performed technical due diligence on the EnergyCell technology leading to joint development agreements (Bosch), purchase orders (Raytheon, Puget, Modesto) or potential collaborations (SK). Primus is also the only company to receive government grants from the U.S. Department of Energy (DOE), the Advanced Research Projects Agency – Energy (ARPA-E), the California Energy Commission (CEC), the Bonneville Power Administration and the DOD's Environmental Security Technology Certification Program. These grants total $20M and are a testament to the strength of Primus Power's product.

Cogenra's mission is to enable widespread adoption of clean renewable energy by providing efficient, flexible solar electricity at lower costs than conventional fossil fuel alternatives. Cogenra offers large distributed and utility-scale solar solutions. Leveraging upstream progress in the crystalline silicon PV cell industry, low-cost construction materials, and innovative business models with highly-scalable worldwide module manufacturing capacity, Cogenra offers a low-cost and proven product requiring minimal capital investment. Funded by Khosla Ventures and led by a team of seasoned executives and engineers, the company has developed and deployed projects with more than 35 commercial, industrial and institutional customers.

Solexel is developing crystalline silicon based PV modules that offer the performance, quality, reliability, and sustainability of the best silicon-based PV at the industry-low cost of non-silicon thin film PV. Solexel's approach is based on a range of highly differentiated, IP-protected technology solutions. The result is the industry's lowest cost of electricity. Solexel offers a superior module design to optimize the aesthetic appeal of standard and BIPV installations.

OSIsoft delivers the PI System, the industry standard in enterprise infrastructure for management of real-time data and events. The OSIsoft PI System is used in manufacturing, energy, utilities, life sciences, data centers, facilities, and the process industries. A global installed base relies upon the OSIsoft PI System to safeguard data and deliver enterprise-wide visibility into operational, manufacturing, and business data. The PI System enables users to manage assets, mitigate risks, comply with regulations, improve processes, drive innovation, make business decisions in real time, and identify competitive business and market opportunities. Located in San Leandro, CA, OSIsoft has a facility of over 85,000 square feet, with a fiber optic loop that enables 10 gigabits per second data transfer capacity.

4. f. Describe the team's history of successfully completing projects (e.g., RD&D projects) and commercializing and/or deploying results/products.

The UCR CE-CERT is a center dedicated to conducting multidisciplinary engineering R&D for over 22 years. As described in 1.e. above, this team recently successfully implemented a SCAQMD funded project with EVs, battery storage, and solar photovoltaics. The total value of the project is about $8 million including matching contributions from the partners. The UCR team members have also completed numerous federal, state and industry funded projects on intelligent transportation, ride sharing, drive motor energy efficiency, and EV research and development.

The UCR CE-CERT team has extensive experience and capabilities in conducting fundamental research, testing, validation, field demonstration and deployment of novel technologies over a period of 22 years. As mentioned above, the PI and two of the Co-PIs in this project are managing for the last three years a multi-sponsored $8 million funded New Grid/Sustainable Integrated Grid Initiative at UCR. This New Grid project involved the design, permitting, construction and deployment of 2.2 MWh Lithium BES, 500 kW of solar PV and multiple EVs. The team successfully navigated through permitting and regulatory hurdles of deployment of these newer technologies at the off-campus research park located in an industrial zone. Dr. Matthew Barth, Director of CE-CERT – the largest research center at UCR, is the PI of this ongoing effort while Dr. Sadrul Ula and Dr. Alfredo Martinez-Morales, are both Co-PIs in this project. For the PORT Project Dr. Ula is the PI, and Dr. Barth and Dr. Martinez-Morales are two of the 3 Co-PIs.

The project manager Mr. Todd and Dr. Barth have been working together for 22 years on intelligent transportation issues including deployment of EVs, telematics, and control strategies to increase vehicle efficiency.

Dr. Ula, Dr. Barth, and Dr. Martinez-Morales have been closely working in a number of solar PV projects as part of the Southern California Research Initiative in Solar Energy (SC-RISE) since 2009.

Dr. Eric Yu became a member of the research group at UCR earlier this year as an Assistant Professor after working as a Technical Manager for Demand Management and Grid Integration of Storage Systems at Southern California Edison.

In summary, this project group is a stable cohesive group of professionals supported by the substantial resources of UCR and CE-CERT (see http://www.cert.ucr.edu).

4. g. Identify past projects that resulted in a market-ready technology. Details of past projects and market-ready technology are included in attachment 9, Reference and Work Product Form.

The UCR team has completed an array of smart grid and renewable integration projects such as, the New Grid project: integrating photovoltaics, energy storage, and a local utility for electric transportation, and the evaluation of energy efficient HVAC electric motor systems in buildings based on on-site and off-site measurement and testing.

Although UCR has not commercialized any grid-related technologies, we have extensive experience with technology transition in other areas related to energy and environment. The following are a few examples:

• UCR Intellishare. In this project Dr. Barth and Mr. Todd developed a system for sharing electric cars for local trips. In partnership with American Honda R&D, UCR developed hardware and software and conducted a demonstration project, changing key variables (e.g., pricing, access) along the way. The project resulted in multiple patents and development of commercial car-sharing systems.

• Vehicle emissions research. CE-CERT established a consortium including automobile manufacturers, oil companies, and State and Federal environmental agencies to develop technology for measuring emissions from ultra-low-emission vehicles and modeling their impact on urban air quality. Similarly, CE-CERT worked with the U.S. Environmental Protection Agency and multiple diesel engine manufacturers to develop a laboratory and protocols for measuring heavy-duty truck emissions under real-world operating conditions – a project that led to the establishment of standard protocols for on-road emissions measurements. That, in turn, led to development of techniques for measuring emissions from nonroad heavy-duty and light-duty equipment, ranging from lawn trimmers to ships and aircraft. CE-CERT now hosts an annual Portable Emissions Measurement Systems workshop for industry and regulators to share developments in this field (see http://www.cert.ucr.edu/events/pems2014/ for information on the most recent workshop).

• Commercial cooking. CE-CERT has worked with numerous manufacturers of grills and emission control systems, restaurant companies, and utility companies to measure the Applicant: University of California, Riverside Control Number: 1149-1510 energy efficiency and environmental performance of commercial cooking technologies. This work has resulted in the establishment of measurement protocols for regulatory purposes.

• Paint and coating environmental impacts. In partnership with the U.S. Environmental Protection Agency and the paint and coatings industry, CE-CERT established the world's most advanced atmospheric reaction laboratory (http://www.cert.ucr.edu/research/apl/) to measure the atmospheric reactivity of volatile organic compounds under low-NOx ambient conditions. The results have been used to guide development of regulations on reformulation of paint and coatings.

4. h. Provide current references, meaning within the past three years.
The references and work products have been included in Attachment 9.

4. i. Identify any collaboration with utilities, industries, or others. Explain the nature of the collaboration and what each collaborator will contribute.
Before joining the faculty at UCR, Dr. Yu, worked at SCE for over three years. During this period he worked with a multitude of industry partners and the California ISO. Locally, the UCR research team has worked closely with the Riverside Public Utilities (RPU) over the last decade. Dr. Martinez-Morales, as PI, has received funding from RPU through its Energy Innovations Grant Program. Dr. Ula and Dr. Barth are Co-PIs on a R&D that is to start very soon (before end of the year) with RPU.

4. j. Respond to the following questions. Include an explanation for any "yes" answer:

Q: Has your organization been involved in a lawsuit or government investigation within the past five years?
A: The University of California is a large organization, and some matters inevitably end up in lawsuits. The University has been subject of routine government audits.
Q: Does your organization have overdue taxes?
A: No
Q: Has your organization ever filed for or does it plan to file for bankruptcy?
A: No
Q: Has any party that entered into an agreement with your organization terminated it, and if so for what reason?
A: The University of California has hundreds of contracts, and it is not uncommon for some to be terminated for reasons including project completion as planned, insufficient funds, or changes in needs.
Q: For Energy Commission agreements listed in the application that were executed (i.e., approved at a Commission business meeting and signed by both parties) within the past five years, has your organization ever failed to provide a final report by the due date indicated in the agreement? Not to our knowledge.

4. k. Commitment letters (for match funding, test sites, or project partners). See Attachment 11 Commitment Letters.
Please see Attachment 11 for commitment letters from Primus Power, Cogenra, and OSIsoft.

5. Budget and Cost Effectiveness

5. a. Reasonableness of the requested EPIC funds relative to the project goals, objectives, and tasks.
The technologies being deployed can revolutionize the clean transportation sector and grid connection industries. The funding requested is reasonable compared to the potential savings to California's electricity rate payers. Most of the components used are commercially available products which minimizes cost.

5. b. Justify the reasonableness of costs for direct labor, non-labor (e.g., indirect overhead and general and administrative costs, and subcontractor profit), and operating expenses by task.
All costs budgeted for personnel are based on actual current monthly salary rates for named people. For to-be-hired or to-be-named positions, salary rates are from published scales or prevailing rates for those job classifications. Benefit rates are composites for each job classification; the University reviews them annually and updates them as needed. Benefits include graduate student tuition/fees in year 1.

Costs for travel are based on calculations of the number of trips required to Sacramento and to the field site based on the current federal mileage reimbursement rate. Materials and supplies costs are based on estimates of the principals for the anticipated costs listed. The basis of estimate is the PIs' experience with projects of similar scale.

Equipment is classified as a single item costing more than $5,000 and having a useful life of more than one year. Equipment items are budgeted based on current price quotations from vendors and include shipping and sales tax as applicable.

5. c. Explain why the hours proposed for personnel and subcontractors are reasonable to accomplish the activities in the Scope of Work (Attachment 3).

The labor mix and overall personnel budget were determined based on the anticipated needs of the project. It should be noted that the cost sharing includes substantial engineering effort by various industry partners. The labor allocation assures that sufficient qualified and experienced personnel will be in place to complete the scope of work and keep the project on schedule and on budget.

5. d. Explain how the applicant will maximize funds for technical tasks and minimize expenditure of funds for program administration and overhead.

No direct costs are allocated to overhead functions such as administration. University of California Federally approved Facilities and Administrative (F&A) rate of 52.0% of Modified Total Direct Costs.

The project partners have many years of experience completing high technology projects and knows the amount of hours required to complete projects. Similarly, UCR personnel have substantial experience with research and development projects and the effort necessary for carrying them out.

6. Funds Spent in California

Substantially all of the funds in this project will be spent in California. All of the direct labor and benefits will be expended in California, and we anticipate that all of the hardware to be purchased will be sourced from California.

Details of anticipated expenditures on materials, supplies, equipment, and travel are found in Tab B-4 of Attachment 7, *Budget Forms.*

7. Ratio of Unloaded Labor Rates to Loaded Labor Rates

The Rates Summary worksheet (Tab B-7) in the budget forms compares the weighted direct labor and fringe benefits rate to the weighted loaded rate. This ratio, as a percentage, is multiplied by the possible points for this criterion.

This calculation is found in Tab B-7 of Attachment 7, Budget Forms.

8. Match Funding

Attachment 11 includes letters detailing the cash and in-kind contributions from Cogenra, Primus Energy, and OSIsoft. All participants understand that matching fund commitments are irrevocable. The commitments identified in these letters are made without qualifications. If for any reason the resources described are not available, the University and industry partners will identify substitute resources that fulfill the matching commitment and the needs of the project.

References

[1] A. Langton and N. Crisostomo, “CPUC Vehicle - Grid Integration: A Vision for Zero-Emission Transportation Interconnected throughout California’s Electricity System,” Emerging Procurement Strategies Section, Energy Division, California Public Utilities Commission October 2013 R. 13-11-XXX

[2] www.intel.com, http://www.intel.com/content/dam/www/public/us/en/documents/solution-briefs/energy-smart-grid-solution-blueprint.pdf, accessed 10-20-2014.

[3] www.osisoft.com, http://www.osisoft.com/software-support/what-is-pi/What_Is_PI.aspx, accessed 10-20-2014.

ATTACHMENT 5
Project Team Form

Identify all key personnel assigned to the project, using the table below (**one page** maximum per individual, see the formatting requirements in Part III, Section A). "Key personnel" are individuals that are critical to the project due to their experience, knowledge, and/or capabilities. **Include at a minimum the project manager, principal investigator (if applicable), and employees of any major subcontractor (i.e., a subcontractor receiving at least 25% of Commission funds or $100,000, whichever is less).** Attach a **resume** for each individual (**two pages** maximum, printed double-sided).

Team Member # 1 of 12	
Name of Individual	Alfredo A. Martinez-Morales, Ph. D.
Position Title	Research Faculty
Employer's Name and Address (street, city, and zip code)	University of California, Riverside College of Engineering-Center for Environmental Research and Technology Mail Code 022 University of California Riverside, CA 92521
Individual's Phone Number and Email Address	(951) 781-5652 alfmart@cert.ucr.edu
Job Description	Research Faculty, College of Engineering Center for Environmental Research and Technology
Role and Responsibilities in the Proposed Project	Role: Principal Investigator and Project Manager Responsibilities: Dr. Martinez-Morales will have overall responsibility for project design, execution, management, and reporting.
Experience, Capabilities, and Credentials	Alfredo Martinez-Morales, is the Managing Director of the Southern California Research Initiative for Solar Energy (SC-RISE) and Research Faculty at the Center for Environmental Research and Technology (CE-CERT) and the Winston Chung Global Energy Center (WCGEC). Dr. Martinez-Morales received his Ph.D., M.S. and B.S. degrees in electrical engineering from UCR. His current research includes concentrated photovoltaics (CPV), dye sensitized solar cells (DSSCs), ordered bulk-heterojunction (OBHJ) solar cells, Lithium-ion batteries (LiBs), and highly integrated renewable and energy storage systems. Dr. Martinez-Morales took on his current role in 2010. His research experience in materials science, device fabrication, systems engineering, distributed generation, and manufacturing of advanced photovoltaic and battery technologies positions Dr. Martinez-Morales to lead this project. Particularly, Dr. Martinez-Morales in his role as Research Faculty with SC-RISE, CE-CERT, and WCGEC, has established joint research projects in collaboration with solar energy companies, energy storage companies, economic development agencies, and community colleges, among other organizations. Dr. Martinez-Morales has written or co-written numerous research articles in the fields of nanoelectronics, energy generation and energy storage. Dr. Martinez-Morales is one of the PIs in the Sustainable Integrated Grid Initiative at UCR, and has contributed in the design, permitting and implementation stages of the SIGI smartgrid testbed system.

ATTACHMENT 5
Project Team Form

Alfredo A. Martinez-Morales, Ph.D.

Managing Director & Research Faculty
Southern California Research Initiative for Solar Energy (www.scrise.ucr.edu)
Center for Environmental Research and Technology (www.cert.ucr.edu)
1084 Columbia Ave., Riverside, CA 92507
951-781-5652; alfmart@cert.ucr.edu

Professional Preparation

College/University	Major	Degree & Year
University of California, Riverside	Electrical Engineering	B.S., 2005
University of California, Riverside	Electrical Engineering	M.S., 2008
University of California, Riverside	Electrical Engineering	Ph.D., 2010

Appointments

2010-Present	University of California, Riverside – Southern California-Research Initiative for Solar Energy, Managing Director
2005 - 2010	University of California, Riverside – Electrical Engineering Department, Graduate Researcher
2009 - 2009	Tohoku University, Japan – Fluctuation Free Facility for New Information Industry, NSF/EAPSI Researcher Fellow
2005-2005	University of California, Los Angeles – Electrical Engineering Department, UC LEADS Undergraduate Researcher Fellow
2003-2005	University of California, Riverside – Electrical Engineering Department, UC LEADS Undergraduate Researcher Fellow

Publications

1. **Alfredo A. Martinez-Morales,** Krishna V. Singh, G. T. Senthil Andavan, Krassimir N. Bozhilov, and Mihrimah Ozkan. *Chem. Mater.* **2007,** *19,* 2446-2454.
2. **Alfredo A. Martinez-Morales,** Nathaniel G. Portney, and Mihrimah Ozkan. *ACS Nano* **2008**, *2*,191-196.
3. **Alfredo A. Martinez-Morales**, Nathaniel G. Portney, Yu Zhang, Giuseppe Destito, Gurer Budak, Ekmel Ozbay, Marianne Manchester, Cengiz S. Ozkan, and Mihrimah Ozkan. *Adv. Mater.* **2008,** *20,* 1-5.
4. Mario Olmedo, **Alfredo A. Martinez-Morales**, Gang Liu, Emre Yengel, Cengiz S. Ozkan, Chun Ning Lau, Mihrimah Ozkan, Jianlin Liu. *Thin Solid Films.* **2010**, *518*, S35-S37.
5. **Alfredo A. Martinez-Morales**, Miroslav Penchev, Jiebin Zhong, Xiaoye Jing, Krishna V. Singh, Mihrimah Ozkan, Emre Yengel, M. Ibrahim Khan, Cengiz S. Ozkan. *J. Nanosci. Nanotech..* **2010***, 10,* 6779-6782..

Current Projects

- Feasibility Study on Using Utility Scale Solar as an Air Quality Mitigation Strategy in the Salton Sea.
- Dye-Sensitized Solar Cells Based on a ZnO NW-TiO_2 NP Photo-Anode and a Solvent Free PEG-TiO_2 Composite.
- Graphene as a Thermal Interface Material for Concentrated Photovoltaics.
- Hybrid Nanostructure of ZnO Nanowires and TiO_2 Nanoparticles and its Applications for Dye-Sensitized Solar Cells

- The New Grid: Integrating Photovoltaics, Energy Storage, and a Local Utility for Electric Transportation.
- Economic Progress through Sustainability: A Feasibility Study for California's Inland Empire
- CPV Receiver for Solar Parabolic Troughs

Synergistic Activities

Judge of Technical Papers, 3rd Annual Inland Empire Solar Boat Competition Challenge, 2011.
Formal Middle School Student Mentor, Riverside STEM Academy, Science Fair Competition 2012-2013.
Teaching Collaborator, Introductory Course to Solar Energy, Alvord High School, 2013-2014.
NSF EPSI ENG Panel P140562, January 2014.
Panel Member, UC LEADS Symposium, UC Riverside, March 2014.
Engineering Expert in Energy, K-12 Alliance Cadre, Cohort 10-Project Prototype, 2014-2017.

Honors

Awardee, National Hispanic Scholarship Fund 2002-2003, 2003-2004.
Awardee, UCR-BCOE/NSF Scholarship 2002-2003
Recipient, McNair Scholars Program, Claremont Graduate University, Summer 2003
First place winner, Best Poster for UCR Undergraduate Research, BCOE Industry Day, 2003
Awardee, UC LEADS Research Scholarship, UCR, 2003-2004, 2004-2005.
Recipient, Office of Instructional Development Student Minigrant, UCR, Fall 2004.
First place winner, Best Poster in Graduate Research, EE Board of Advisors, UCR 2007.
Awardee, Graduate Research Mentorship Programs Fellowship, UCR, 2008-2009
Awardee, NSF East Asia and Pacific Summer Institutes for U.S. Graduate Students 2009
Awardee, UC Dissertation Year Fellowship, UCR, 2009-2010

Collaborators & Other Affiliations

Collaborators. Jing C. Zhou (UCLA); Bruce Dunn (UCLA); Christina O. Baker (UCLA); Richard B. Kaner (UCLA); Mario Olmedo (UCR); Jianlin Liu (UCR); Christopher Dames (UCR); Cengiz S. Ozkan (UCR); Mihrimah Ozkan (UCR); Kawai Tam (UCR); Maria C. Simani (UCR); Nosang V. Myung (UCR); Lorenzo Mangolini (UCR); David Kisailus (UCR); Heejung Jung (UCR); Yadong Yin (UCR); Alexander Balandin (UCR); Qi Zhu (UCR); Wei Ren (UCR); Feras Abougalala (UCR); Matthew J. Barth (UCR); Sadrul Ula (UCR); Ajith Weerasinghe (Fresno State); Heather Smith (RCC).

Industry Collaborator. Terrafore, ArmoredSeal, Applied Materials, SolarReserve, Amonix, Renova, SolarMax Inc., Winston Battery, Bourns Inc., Balqon Corporation, Complete Coach Works, Wells Materials Research, Inc.

Graduate Advisors and Postdoctoral Sponsors. Mihrimah Ozkan (UCR)

Thesis Advisors and Postgraduate-Scholar Sponsor. Stefan Pitzek, MS EE (9/2010-12/2011); Jun Su, MS EE (1/2012-6/2012); Ian J. Miller, MS MSE (9/2011-3/2014); Taehoon Lim, PhD MSE (9/2011-present); Fei Gu, PhD MSE (3/2014-present); Ye Li, PhD EE (1/2014-present); Yun Xue, MS EE (1/2014-present).

Other Graduate Students. Margeson, MBA (6/2012-9/2012); Charanjit Singh, MBA (6/2012-9/2012); Kazuki Takehashi, MBA (6/2012-present); Sothida Vanitsthian, MBA (6/2012-present).

ATTACHMENT 5
Project Team Form

Team Member # 2 of 12	
Name of Individual	Michael Todd, P.E.
Position Title	Principal Development Engineer
Employer's Name and Address (street, city, and zip code)	University of California, Riverside College of Engineering-Center for Environmental Research and Technology Mail Code 022 University of California Riverside, CA 92521
Individual's Phone Number and Email Address	(951) 781-5751 mike@cert.ucr.edu
Job Description	Project Manager and Lead Engineer in smartgrid technology, electric vehicles and energy projects.
Role and Responsibilities in the Proposed Project	Role: Project Manager Responsibilities: Mr. Todd will be in charge of coordinating the execution and successful completion of the project.
Experience, Capabilities, and Credentials	Michael Todd is a Principal Development Engineer with the College of Engineering-Center for Environmental Research and Technology within the Bourns College of Engineering at UC Riverside. Mr. Todd is also registered as a California Professional Engineer with expertise on Intelligent Transportation Systems (ITS), control systems, telematics, communications, and microgrid power systems. Project management experience has fostered numerous collaborative relationships with cities, counties, Caltrans, FHWA, MPO's, and regional transit authorities. Mr. Todd consistently and successfully leads technical staff and engineers in the implementation of transportation, transit, ITS technology projects, systems analysis, microgrid development and operation. Mr. Todd has extensive experience in the local, regional, state, and federal deployment efforts and associated project programming process. Having been directly responsible in the budgetary management of multi-million dollar systems implementations and operations, Mr. Todd is very capable with program development, task management, accounting and budgeting methods. Mr. Todd's career within the University of California system has allowed for a diverse participation and management of energy related projects. Mr. Todd has significant experience in system models, surveys, and analysis methods for evaluating performance, communication, reliability, efficiencies and associated costs. In conjunction with systems analysis methods Mr. Todd collaborates with public and private affiliates to implement transportation and energy alternatives which promote efficiency and emissions reductions. Mr. Todd documents and presents related work at the local, state, national and international levels and participates in committees and subcommittees. Mr. Todd is the lead Development Engineer in the Sustainable Integrated Grid Initiative at UCR, and has overseen the design, permitting and implementation stages of the SIGI smartgrid testbed system.

ATTACHMENT 5
Project Team Form

MICHAEL TODD P.E.
Principal Development Engineer
Center for Environmental Research and Technology
College of Engineering, University of California, Riverside, CA 92521
Tel: (951) 781-5751 Fax: (951) 781-5790 E-mail: mike@cert.ucr.edu

EDUCATION

Institute	Major/Area	Degree	Year
University of California-Riverside	Environmental Engineering	B.S.	1994

PROFESSIONAL EXPERIENCE

Michael Todd is a Principal Development Engineer with the College of Engineering-Center for Environmental Research and Technology within the Bourns College of Engineering at UC Riverside. Mr. Todd is also registered as a California Professional Engineer with expertise on Intelligent Transportation Systems (ITS), control systems, telematics, communications, and microgrid power systems. Project management experience has fostered numerous collaborative relationships with cities, counties, Caltrans, FHWA, MPO's, and regional transit authorities. Mr. Todd consistently and successfully leads technical staff and engineers in the implementation of transportation, transit, ITS technology projects, systems analysis, microgrid development and operation. Mr. Todd has extensive experience in the local, regional, state, and federal deployment efforts and associated project programming process. Having been directly responsible in the budgetary management of multi-million dollar systems implementations and operations, Mr. Todd is very capable with program development, task management, accounting and budgeting methods. Mr. Todd's career within the University of California system has allowed for a diverse participation and management of energy related projects. Mr. Todd has significant experience in system models, surveys, and analysis methods for evaluating performance, communication, reliability, efficiencies and associated costs. In conjunction with systems analysis methods Mr. Todd collaborates with public and private affiliates to implement transportation and energy alternatives which promote efficiency and emissions reductions. Mr. Todd documents and presents related work at the local, state, national and international levels and participates in committees and subcommittees. Mr. Todd is the lead Development Engineer in the Sustainable Integrated Grid Initiative at UCR, and has overseen the design, permitting and implementation stages of the SIGI smartgrid testbed system.

RELEVANT PEER-REVIEWED PUBLICATIONS

Barth, M., and Michael Todd. 2002. "UCR IntelliShare: an intelligent shared electric vehicle testbed at the University of California, Riverside". *International Association for Traffic and Safety Sciences (IATSS) Research Journal* Vol. 27, No. 1, 2003, pp. 48-58.

Barth, M., and M. Todd. 2001. "User behavior evaluation of an intelligent shared electric vehicle system". *Transportation Research Record* No. 1760, pp. 145-152, Transportation Research Board, National Academy of Science.

Barth, M., M. Todd, and H. Murakami. 2000. "Using intelligent transportation system technology in a shared electric vehicle program". *Transportation Research Record* No. 1731, pp. 88-95, Transportation Research Board, National Academy of Science.

Barth, M. and M Todd. 1999. "Simulation model performance analysis of a multiple station shared vehicle system". *Journal of Transportation Research Part C: Emerging Technologies*. Volume 7, pp. 237-259.

OTHER SELECTED PEER-REVIEWED PUBLICATIONS

Barth, M. and M. Todd. "Examining Intelligent Transportation Technology Elements and Operational Methodologies for Shared-Use Vehicle Systems". *Transportation Research Record*, December, 2003. 18 pp.
Barth, M., and M. Todd. "ITS Architecture Design and Performance Evaluation of a Multiple-Station Shared-Use Vehicle System". *IEEE Transactions on Intelligent Transportation Systems*, July 2002. 23 pp.
Barth, M., L. Xue, Y. Chen, and M. Todd. "CDPD/DSRC Hybrid Communication Architecture for Intelligent Shared-Use Vehicle Systems". *IEEE Transactions on Vehicular Technology*, June 2002. 22 pp.

RELEVANT NON PEER-REVIEWED PUBLICATIONS/PATENTS

M. Todd, M. Barth, H. Murakami, and M. Smith. "Shared Vehicle System and Method with System for Carrying a First Vehicle with a Second Vehicle." US Patent No. 6,253,980 Date Issued: July 3, 2001.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Vehicle Sharing System and Method for Controlling or Securing Vehicle Access and/or Enablement US Patent No. 6,850,153.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Vehicle Sharing System and Method with Parking State Detection." US Patent No. 6,636,145.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Vehicle Sharing System and Method with Vehicle Parameter Tracking." US Patent No. 6,941,197.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Vehicle Sharing System and Method for Allocating Vehicles Based on State-of-Charge." US Patent No. 6,850,898.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Shared Vehicle System and Method with Vehicle Relocation." US Patent No. 6,947,881.
M. Todd, M. Barth, H. Murakami, S. Yano, and K. Nakamura. "Method for Efficient Vehicle Allocation in Vehicle Sharing System." US Patent No. 6,975,997.

PROFESSIONAL LICENCES

- CA Professional Engineer: License No. TR-2539

ATTACHMENT 5
Project Team Form

Team Member # 3 of 12	
Name of Individual	Matthew J. Barth, Ph. D.
Position Title	Director, College of Engineering-Center for Environmental Research and Technology
Employer's Name and Address (street, city, and zip code)	University of California, Riverside College of Engineering-Center for Environmental Research and Technology Mail Code 022 University of California Riverside, CA 92521
Individual's Phone Number and Email Address	(951) 781-5782 barth@ece.ucr.edu
Job Description	Full-Professor of Electrical and Computer Engineering
Role and Responsibilities in the Proposed Project	Role: Co-PI Responsibilities: Dr. Barth will assist in the engineering design; data collection design; data analysis. Review commercially available hardware and select most suitable ones for adapting in this project.
Experience, Capabilities, and Credentials	Matthew Barth is the Yeager Families Professor at the College of Engineering, University of California-Riverside. He is part of the intelligent systems faculty in Electrical Engineering and is also serving as the Director for the Center for Environmental Research and Technology (CE-CERT), UCR's largest multi-disciplinary research center. He received his B.S. degree in Electrical Engineering/Computer Science from the University of Colorado in 1984, and M.S. (1985) and Ph.D. (1990) degrees in Electrical and Computer Engineering from the University of California, Santa Barbara. Dr. Barth joined the University of California-Riverside in 1991, conducting research in Intelligent Transportation Systems. Dr. Barth's research focuses on applying engineering system concepts and automation technology to Transportation Systems, and in particular how it relates to energy and air quality issues. His current research interests include ITS and the Environment, Transportation/Emissions Modeling, Vehicle Activity Analysis, Advanced Navigation Techniques, Electric Vehicle Technology, and Advanced Sensing and Control. Dr. Barth is active with the U.S. Transportation Research Board serving in a variety of roles in several committees, including the Committee on ITS and the Committee on Transportation Air Quality. He was awarded the TRB Pyke Johnson Award for TRB outstanding paper in 2007. In 2011, he was one of the winners of the Connected Vehicle Technology Challenge sponsored by U.S. Department of Transportation's Research and Innovative Technology Administration (RITA). He has also served on a number of National Research Council (NRC) Committees. Dr. Barth has also been active in IEEE Intelligent Transportation System Society (ITSS) for many years, where he is currently serving as the IEEE ITSS President for 2014-2015.

ATTACHMENT 5
Project Team Form

Matthew J. Barth, Ph.D.
Yeager Family Professor of Engineering
Director, Center for Environmental Research and Technology
CE-CERT 022, University of California, Riverside, CA 92521-0434 barth@ee.ucr.edu

Professional Preparation

University of Colorado, Boulder, Electrical Engineering	B.S., 1984
University of California, Santa Barbara, Electrical Engineering	M.S., 1986
University of Tokyo, Japan, Research Student, Sys Engineer	1986-87
University of California, Santa Barbara, Electrical Engineering	Ph.D., 1990

Appointments

1991-present. Assistant, Associate, then full Professor of Electrical Engineering; also Director of the Bourns College of Engineering-Center for Environmental Research and Technology (CE-CERT).

1990-91. Visiting Researcher, Department of Systems Engineering, Faculty of Engineering Science, Osaka University, Japan.

1985-89. Graduate Research Assistant, Electrical Engineering and Center for Robotic Systems in Microelectronics, University of California, Santa Barbara.

1985-86. Member of the Technical Staff, Advanced Technology Division, General Research Corporation, Santa Barbara, CA.

1979-84. Undergraduate Research Assistant, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder.

Research Areas of Interest

Intelligent Transportation Systems, Electric Vehicle Technology, Innovative Energy Systems, Vehicle Activity Analysis, Robotics, and Advanced Sensing and Control.

Selected Relevant Publications

H. Xia, K. Boriboonsomsin, and M. Barth (2013). “Dynamic ECO-driving for signalized arterial corridors and its indirect network-wide energy/emissions benefits.” *Journal of Intelligent Transportation Systems*, 17(1), 31-41.

M. Barth, S. Mandava, K. Boriboonsomsin, and H. Xia (2011). “Dynamic ECO-driving for arterial corridors.” Proceedings of the 1st IEEE Forum on Integrated and Sustainable Transportation Systems, Vienna, Austria, June 29 – July 1.

M. Barth and K. Boriboonsomsin (2009) “Energy and Emissions Impacts of a Freeway-Based Dynamic Eco-Driving System”, *Transportation Research Part D: Environment* 14, 400-410, Elsevier Press.

Li, M., Boriboonsomsin, K., Wu, G., Zhang, W.-B., and Barth, M. (2009). “Traffic energy and emission reductions at signalized intersections: a study of the benefits of advanced driver information.” *International Journal of Intelligent Transportation Systems Research*, 7(1), 49-58.

M. Barth and K. Boriboonsomsin (2008) “Real-World CO_2 Impacts of Traffic Congestion”, *Transportation Research Record* No. 2058, pp 163-171, Transportation Research Board, National Academy of Science.

Other Significant Publications

W. Zhu, K. Boriboonsomsin, and M. Barth (2009) “Defining a Freeway Mobility Index for Roadway Navigation”, *Journal of Intelligent Transportation Systems* 14(1), 37-50.

Boriboonsomsin, K., Barth, M., and Xu, H. (2009). "Improvements to on-road mobile emissions modeling of freeways with high-occupancy vehicle facilities." *Transportation Research Record*, 2123, 109-118.

K. Boriboonsomsin and M. Barth (2009) "Fuel and CO_2 Impacts from Advanced Navigation Systems That Account for Road Grade", to appear, *Transportation Research Record*, Transportation Research Board, National Academy of Science.

K. Boriboonsomsin, A. Vu, and M. Barth (2011). "Evaluation of driving behavior and attitude towards eco-driving: A Southern California case study." Proceedings of the 90th Annual Meeting of the Transportation Research Board, Washington, DC, January 23-27.

M. Barth, K. Boriboonsomsin, and A. Vu (2007). "Environmentally-Friendly Navigation", *IEEE Intelligent Transportation Systems Conference*, Seattle, Washington, September, 2007.

Collaborators and Other Affiliations

Collaborators and Co-authors:

Boriboonsomsin, K., University of California, Riverside; Farrell, J., University of California, Riverside; Ishiguro, H., Osaka University, Japan; Norbeck, J., University of California, Riverside; Ross, M., University of Michigan; Shaheen, S., Shladover, S., Varaiya, P., University of California, Berkeley, Partners for Advanced Transit and Highways (PATH) program; Sperling, D., Institute of Transportation Studies, University of California, Davis.

Graduate and Postdoctoral Advisors:

Hackwood, S., Director of California Council on Science and Technology; Beni, G., professor, electrical engineering, UC Riverside; Hu, E., professor, electrical and computer engineering, UC Santa Barbara; Tsuji, S., Dean, Systems Engineering, Wakayama University, Japan; Asada, M., systems engineering, Osaka University, Japan.

Postgraduate Scholar Sponsor (4):

Feng An, postdoc 1995-2000; Koji Kato, postdoc (1999-2000); Kanok Boriboonsomsin, postdoc 2004-2007, Liu Huan, postdoc 2009-present.

Ph.D. Dissertation Advisor (10):

Jie Du Ph.D. (EE) 2006, Karen Xu Ph.D. (EE) 2006, Meng Cao Ph.D., 2009, Weihua Zhu Ph.D. 2009, Scott Boskovich Ph.D. (EE) in progress, Lili Huang Ph.D. (EE) in progress, George Scora Ph.D. (CEE) in progress, Anh Vu Ph.D. (EE) in progress, Fred Lawton Ph.D. (EE) in progress, Qichi Yang Ph.D. (EE) in progress.

M.S. Thesis Advisor (23):

Colin Barrows M.S. (EE) 1998, Cheng Zhao M.S. (CS) 1998, Jenny Li, M.S. (CS) 1999; Xiaolan Li M.S. (CS) 2000; Yuan Li M.S. (CS) 2000, Jing Han M.S. (EE) 2001; Xue Lei M.S. (EE) 2001; Gokce Dane M.S. (EE) 2001; Zhiyu He M.S. (EE) 2002; Rong Hong M.S. (CS) 2003; Shiqin Wang M.S. (EE) 2003; Raymond Li M.S. (EE) 2003; Jason Masters M.S. (EE) 2003; Angelo Ledesma M.S. (EE) 2006; Long Nguyen M.S. (EE) 2006; Anh Vu M.S. (EE) 2007; Oscar Servin M.S. (EE) 2008; George Scora M.S. (CEE) 2008; Henry Chen M.S. (EE) 2008; Sindhura Mandava M.S. (EE) in progress; Joseph Silva M.S. (EE) in progress; Yujing Liu M.S. (EE) in progress.

ATTACHMENT 5
Project Team Form

Team Member # 4 of 12	
Name of Individual	Nanpeng Yu, Ph. D.
Position Title	Assistant Professor
Employer's Name and Address (street, city, and zip code)	University of California, Riverside 900 University Ave. Riverside, CA 92521
Individual's Phone Number and Email Address	(626) 720-7027 nanpeng.yu@ece.ucr.edu
Job Description	Assistant Professor of Electrical and Computer Engineering
Role and Responsibilities in the Proposed Project	Role: Co-PI Responsibilities: Dr. Yu will assist in the deployment design; data collection design; data analysis. Review existing advanced strategies for energy management, and the evaluation of project benefits.
Experience, Capabilities, and Credentials	Nanpeng Yu has devoted a majority of his academic and industry career on power system optimization, electricity market design, renewable resource integration and energy storage system valuation. Throughout Dr. Yu's Ph.D. research, he developed multi-agent power system and electricity market simulation software to design electricity market. In addition, he designed financial risk management framework for power system operation and trading. His academic success in the area of power engineering research is demonstrated by his publication record in top journal and international conferences. Serving as senior power system planner and project manager at Southern California Edison, Dr. Yu led many research and development projects that resulted in millions of dollars of saving for electric ratepayers. He was the lead developer of SCE's utility-owned energy storage valuation and optimization tool. He served as project manager to develop and implement automatic demand response that integrates over 1,000 MW of demand response resources into CAISO market. He also led many generation asset optimization projects at SCE.

ATTACHMENT 5
Project Team Form

Nanpeng Yu

EDUCATION

Ph.D. in Electrical Engineering, Dec. 2010
Iowa State University, Ames, Iowa
Dissertation Title: "Evaluation of wholesale electric power market rules and financial risk management by agent-based simulations"
Major Professors: Chen-Ching Liu and Leigh Tesfatsion

Master of Science in Economics, Dec. 2012
Iowa State University, Ames, Iowa
Major Professor: Leigh Tesfatsion

Master of Science in Electrical Engineering, Dec 2007
Iowa State University, Ames, Iowa
Major Professor: Chen-Ching Liu

Bachelor of Science in Electrical Engineering, Jun. 2006
Tsinghua University, Beijing, China

RESEARCH AND TEACHING EXPERIENCE

Assistant Professor, Department of Electrical and Computer Engineering, University of California, Riverside, (Starting from Aug. 2014)

S**enior Power System Planner, Southern California Edison, California (Jan. 2011 – July. 2014)**

- **Wind and Solar Integration in California**
  Collaborate with industry partners to conduct research in wind and solar forecast, wind farm operations in wholesale electricity market, wind farm curtailment and hydro optimizations.
- **Wholesale Electricity Market Design**
  Design and develop flexible ramping product and flexible capacity product for California's power market to accommodate distributed renewable resources.
- **Big Data Analytics in Power Distribution System**
  Develop big data analytics applications in power distribution system utilizing heterogeneous and complex data to improve distribution system operation and planning.
- **Interaction between Greenhouse Gas (GHG) and Power Market**
  Analyze GHG regulation and GHG market's impact on power system operations such as short-term unit commitment and long-term generation and transmission planning process. Develop fundamental and stochastic process models for GHG market.

Research Assistant, Iowa State University, Iowa (Jul. 2006 – Dec. 2010)

- **Completed Power Systems Engineering Research Center (PSERC) project "Agent Modeling for Integrated Power System".**

Proposed and developed a flexible and integrative methodology and software platform capable of evaluating new electric market designs from both engineering and economic points of views. This allows the regulators and policy makers to conduct a comprehensive and rigorous testing before implementing new market design features.

- **Completed Electric Power Research Center (EPRC) project "Forecasting Grid Congestion for Transmission Grid Operation and Investment".**
  Developed a unified methodology, a four-stage process, to facilitate market participants' management of financial risk in wholesale electric power markets. Constructed an analytical and computation model to analyze the financial bilateral contract negotiation problem within the proposed financial risk management framework.

Intern, Midwest Independent System Operator, Indiana (Dec. 2009 – Feb. 2010)

- Conducted research on grid congestion forecast and developed credit risk analysis models for Financial Transmission Rights (FTR). Worked with stakeholders to improve the FTR portfolio collateral requirement calculation methodology.

INVITED PRESENTATIONS

[1] Nanpeng Yu, "Integrating Renewable Energy in Electricity Market," Caltech Power Networks and the Smart Grid Research Seminar, Pasadena, CA, March, 2013.
[2] Nanpeng Yu, "Evaluation of Market Rules Using a Multi-Agent Platform," Power System Engineering Research Center Industry Advisor Board Meeting, Ames, IA, May 2008.
[3] Nanpeng Yu, "Multi-agent Systems and Electricity Markets: State-of-the-art and the Future," IEEE PES General Meeting, Pittsburgh, PA, August 2008.
[4] Nanpeng Yu, "Financial Risk Management in Restructured Wholesale Power Markets: Basic Concepts and Tools," IEEE PES General Meeting, Minneapolis, MN, July 2010.

RECOGNITIONS AND HONORS

- Third Prize Presenter in the IEEE PES General Meeting Poster Contest, 2009
- Top Paper Award in Intelligent System Application to Power System Conference, 2007
- Zheng Geru Scholarship for Excellent Academic Performance, Tsinghua University, 2004
- Dongfeng Automobile Scholarship for Excellent Academic Performance, Tsinghua University, 2003

REFEREE SERVICE

- Reviewer, IEEE PES General Meeting
- Reviewer, IEEE Transactions on Power Systems
- Reviewer, IEEE Transactions on Smart Grid
- Reviewer, European Transactions on Electric Power
- Reviewer, IET Generation, Transmission & Distribution
- Chair, DC Applications and Electric Vehicle Section of 2014 IEEE Power Engineering Society General Meeting, National Harbor, Maryland, July 2014.

ATTACHMENT 5
Project Team Form

Team Member # 5 of 12	
Name of Individual	Sadrul Ula, Ph. D.
Position Title	Co-Director, Winston Chung Global Energy Center
Employer's Name and Address (street, city, and zip code)	University of California, Riverside College of Engineering-Center for Environmental Research and Technology Mail Code 022 University of California Riverside, CA 92521
Individual's Phone Number and Email Address	(951) 781-5676 sula@cert.ucr.edu
Job Description	Full-time researcher and research administrator for large electrical power and renewable energy programs.
Role and Responsibilities in the Proposed Project	Role: Co-PI Responsibilities: Dr. Ula will in the integration, deployment and validation of the pre-commercial technologies.
Experience, Capabilities, and Credentials	Professor Emeritus of Electrical Engineering at the University of Wyoming. Ph.D. in Electrical Engineering, University of Leeds. Over 40 years of experience in the theory, design and implementation of large power generators, motors and power distribution system. Sadrul Ula is the Co-Director of the Winston Chung Global Energy Center at the College of Engineering, University of California – Riverside. He is a Research Faculty at the College of Engineering - Center for Environmental Research and Technology (CE-CERT), UCR's largest multi-disciplinary research center. Prior to joining UCR, he was Professor of Electrical and Computer Engineering at the University of Wyoming for 28 years. During 2004-2005, he served as the Energy Advisor to the Governor of Wyoming – the largest energy producing and exporting state in the country. Dr. Ula's area of expertise is electric power generation, transmission, distribution and utilization, including renewable energy integration in the grid. He was the founding director of Electric Motor Training and Testing Center at the University of Wyoming. He developed innovative methods and algorithms for demand side management using electric motors – the largest energy user as a group in the US. Over the last 4 years, he designed and implemented a number of microgrid systems including 2.2 MWh of battery energy system, 500 kW solar PV, multiple electric vehicle charging systems including supervisory control and data acquisition system.

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Project Team Form

Sadrul Ula

Center for Environmental Research and Technology, University of California - Riverside
1084 Columbia Avenue, Riverside, CA 92507
Tel.: 951-781-5676 (w), 951-781-5790; fax: 951-781-5790

Professional Rank: Co-Director and Research Faculty, Winston Chung Global Energy Center, Center for Environmental Research and Technology, University of California - Riverside

Education: Post-Doctoral, Electrical Engineering and Computer Science Department, Massachusetts Institute of Technology, Cambridge, Massachusetts — 1977-78

Ph.D., Electrical Engineering, University of Leeds, England — 1977

B.Sc. & M.Sc. Electrical Engineering (1968 & 1973)

Years of service:
4 years at UC-Riverside; 28 years of service at the University of Wyoming.

Research Interest:
Electric Power Generation, Electric Power System, Electric Machines, Energy Management, Renewable Energy - Solar and Wind, Energy Education, and K-12 Science & Math Education

Related Experience:
Energy Advisor to the Governor of Wyoming, Wyoming, USA — June 2004 – June 2005
Advisor to the Power Minister, Government of Bangladesh — June 2005 – August 2005

Professional Qualifications:
Society of Petroleum Engineering, Distinguished Lecturer, 1997-98; Conference Chairman, IEEE Region 5 Annual Conference, 1991; Chairman, Centennial Sub-section of IEEE, 1986-91; Member, American Society for Engineering Education; Energy Conversion and Conservation Division, American Society for Engineering Education (ASEE): Chairman, 1988-89 Member, Technical Committee TC8.11, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).

List of Current Externally Funded Grants and Contracts: Indicating PI, Co-PI or Collaborator, Funding Agency, Total Dollar Amount, and Start and End Dates:

1. The New Grid: Integrating Photovoltaics, Energy Storage, and a Local Utility for Electric Transportation; South Coast Air Quality Management District; Co-PI; $2,000,000; 7/12-6/15.
2. Evaluation of Energy Efficient HVAC Electric Motor Systems in Buildings; PI; California Energy Commission; $385,000; 7/11-12/14.
3. Evaluation and Testing of a Novel Vertical Axis Wind Turbine; PI: Wattenburgh Industries; $36,050; 7/10-12/10.

4. An Engineering Approach to Science & Mathematics Education; PI; US Department of Education; $393,500; 7/08-12/10.
5. Transmission Feasibility Study for Wind Energy for the Jake Ochsner Ranch; PI; US Department of Agriculture; 7/08-12/09.
6. Solar and Wind Electric Stock Water Pumping for Grazing Land; PI; US Department of Agriculture – Natural Resources Conservation Service; $418,800; 9/05-11/06.
7. Alleviate Drought Impact on Ranching with the Help of Renewable Energy; PI; Wyoming Business Council (WBC); $500,000; 06/05-06/07.

Publication:

Referred Journal (recent 4 years)

1. Kala Meah, A.H.M. Sadrul Ula, "A New Simplified Adaptive Control Scheme for Multi-Terminal HVDC Transmission Systems," International Journal of Electrical Power and Energy Systems, Vol. 32, No. 4, May 2010, pp 243-253.
2. Pierre, John W.,Tuffner, Francis K.,Anderson, Jeffrey R., Whitman, David L.,Ula, A. H. M. Sadrul; Kubichek, Robert F. Wright, Cameron H. G., Barrett, Steven F., Cupal, Jerry J, Hamann, Jerry C., “A One Credit Hands-On Introductory Course in Electrical and Computer Engineering Using a Variety of Topic Modules,” IEEE Transactions on Education, Vol. 52, No. 2, May 2009.
3. Kala Meah, A.H.M. Sadrul Ula, “A Self-Coordinating Adaptive Control Scheme for HVDC Transmission Systems” Electric Power Systems Research, Vol. 79, No. 11, November, 2009, pp 1593-1603.
4. Kala Meah, A.H.M. Sadrul Ula, “Simple Fuzzy Self-Tuning PI Controller for Multi-terminal HVDC Transmission Systems,” Electric Power Components and Systems, Vol. 36, No. 3, March 2008, pp 224-238
5. Kaili Xu, Kala Meah, A.H.M. Sadrul Ula, “A Novel Method for Reducing Harmonics in Series-connected Rectifiers,” Electric Power Systems Research, Vol. 78, No. 7, July 2008, pp 1256-1264.

Conference Proceedings

1. Tianshu Wei, Taeyoung Kim, Sangyoung Parky, Qi Zhu, Sheldon X.-D. Tan, Naehyuck Changy, Sadrul Ula and Mehdi Maasoumy, “Management and Application for Energy-Efficient Buildings”, 51st IEEE/ACM Design Automation Conference (DAC), San Francisco, CA, June 2014.
2. Yi Zhang, Sadrul Ula and Yibin Zhang, “Wind power availability and increased capacity credit for multiple wind farms,” IEEE PES General Meeting, Minneapolis, Minnesota, USA, 2010.
3. Kala Meah, A.H.M. Sadrul Ula, "Simulation Study of the CIGRE HVDC Benchmark Model with theWSCC Nine-bus Power System Network," IEEE PES Power System Conference and Exposition, March 15-18, 2009, Seattle, WA, USA.
4. Kala Meah, A.H.M. Sadrul Ula, “Simulation Study of the Frontier Line as a Multi-Terminal HVDC System,” IEEE Power and Energy Society General Meeting, July 20- 24, 2008, Pittsburg, PA, USA.
5. Kala Meah, A.H.M. Sadrul Ula, “On-Site Wind Energy Measurement and Preliminary Transmission Assessment: Case Studies in Wyoming,” IEEE Region 5 Conference, April 17-20, 2008, Kansas City, MO, USA.

ATTACHMENT 5
Project Team Form

Team Member 6 of 12	
Name of Individual	Ratson Morad
Position Title	Chief Operating Officer & Vice President of R&D
Employer's Name and Address (street, city, and zip code)	Name: Cogenra Solar Address: 46453 Landing Parkway, Fremont, CA 94538
Individual's Phone Number and Email Address	Phone: 650 230 3406 Email: Ratson.Morad@Cogenra.com
Job Description	Mr. Morad leads all research, development, engineering and operations teams within Cogenra.
Role and Responsibilities in the Proposed Project	Mr. Morad will be the key technical point of contact for the project
Experience, Capabilities, and Credentials	Mr. Ratson Morad brings over 20 years experience building start-up companies and global organizations in the high tech sector, predominantly for photovoltaic and semiconductor equipment. Prior to joining Cogenra, Mr. Morad was president and chief operating officer of DayStar Technologies (DSTI) where he was responsible for design, construction and staffing of a photovoltaic production facility. Previously, he was founding member and vice president of Engineering and Technology at Solyndra, where he was instrumental in developing an innovative PV system. Mr. Morad held earlier executive positions at Applied Materials, including vice president and general manager, where he led the development and commercialization of new 300mm wafer processing systems. Mr. Morad earned his Master of Science degree in Mechanical Engineering from Ben Gurion University in Israel and completed his Business Management studies at the Technion, Israel Institute of Technology.

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Ratson Morad
Chief Operating Officer and Vice President of R&D
Cogenra Solar, Inc.

Prior Experience:

DayStar Technologies, Inc. (DSTI) (Santa Clara, CA) **2/2008 – 7/2009**
(A public company developing and manufacturing new solar PV panels)
President and Chief Operating Officer
Led the operations organization, sales & marketing, legal and human resources. Drove all the activities related to product strategy, customers, manufacturing and the construction and running of a new 100 MW fab for solar PV in Newark, CA.

Solyndra, Inc. (Fremont, CA) **7/2005 – 2/2008**
(A solar energy company developing and manufacturing innovative solar PV panels)
Vice President – Engineering and Technology
Led the development of an innovative new solar module. As part of the founding team, built and staffed the organization, developed the manufacturing strategy, and managed construction of the first 50 MW/year production line in Fremont, CA.

Blue29 Corporation (Sunnyvale, CA) **12/2002 – 7/2005**
(A startup company manufacturing semiconductor capital equipment)
CEO and President
Built and led a startup company from concept stage through funding to full product release and acquisition. Grew the company from 5 employees to more than 70. Introduced and sold new systems and technology to leading customers in the semiconductor industry (AMD, Intel, Toshiba, IBM). Sold the company to KLA-Tencor and established a JV with DNS (Japan).

Applied Materials (AMAT) (Santa Clara, CA) **9/1995 – 12/2002**
(The largest supplier of equipment and services to the semiconductor industry)
VP GM, CMP Division (2000 – 2002)
Led the CMP Product Division, developed and introduced new products which won the business of major customers (Intel, IBM, Toshiba, Sony), and managed an organization of more than 250 employees. Achieved sales of $600M/yr.
Managing Director Engineering, Metal deposition PBG (1998 – 2000)
Developed an ECD (Copper Electro Plating) system, which was a new technology in the Semiconductor industry, and released it in record time from initial concept to customer installation.
Senior Director Engineering, PVD Division (1995 – 1998)
Built and led the team that developed and commercialized the 300mm PVD system from basic concept to successful release.

Elscint Medical Imaging LTD (Haifa, Israel) **1989 – 1995**
(An advanced medical imaging company. The MRI division was acquired by GE Medical.)
Director of R&D, MRI Division
Drove R&D activities of a global company with an installed base of over 400 MRI systems.

Education:
Master of Science in Mechanical Engineering. Ben-Gurion University - Israel
Business Management. Technion - Israel Institute of Technology – Haifa Israel

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Project Team Form

Patents: 29 granted US patents and 32 pending patents in Solar, Semiconductor and MRI

ATTACHMENT 5
Project Team Form

Team Member 7 of 12	
Name of Individual	Dr. Mani Thothadri
Position Title	Vice President Products
Employer's Name and Address (street, city, and zip code)	Name: Cogenra Solar Address: 46453 Landing Parkway, Fremont, CA 94538
Individual's Phone Number and Email Address	Phone: 650 230 3418 Email: Mani.Thothadri@Cogenra.com
Job Description	In charge of product management, marketing, business development and corporate strategy within Cogenra
Role and Responsibilities in the Proposed Project	Principal Investigator and Project Manager
Experience, Capabilities, and Credentials	Dr. Thothadri brings over 15 years of operating experience in the semiconductor, display and solar industries. Prior to joining Cogenra, Dr. Thothadri was a deputy general manager at Applied Materials with P&L responsibility for the Display business segment's physical vapor deposition product. Previously, at Applied Materials, he held roles of increasing responsibility spanning the breadth from engineering to product management. Dr. Thothadri holds a Ph.D. in engineering from Cornell University in New York. He has served on technical panels, authored and co-authored more than 15 technical papers in peer-reviewed journals.

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Mani Thothadri, Ph.D.

Current Positon
Vice President, Products
Cogenra Solar, Inc.

Prior Experience:
Applied Materials (AMAT) (Santa Clara, CA) 1/1999 – 2/2011
(The largest supplier of equipment and services to the semiconductor, Display & Solar industries)

Deputy General Manager, Display (LCD) Physical Vapor Deposition (PVD) Product Division
Responsible for overall financial management of the Display PVD group, with P&L responsibility to maximize revenue, gross margins and contributed profits. Revenue and profitability for the division reached record levels in FY2010 with annual revenue of ~$200M. Other responsibilities include strategic planning, operational and staff management including goal setting and accountability.

Director, Global Product Management & Key Accounts, Solar Laser Scribe Product Division
Part of a team tasked with an aggressive timeline to develop & commercialize a laser scribe product for thin-film solar division. Led product management, technical marketing and key account technologist teams resulting in critical penetrations and achieving customer acceptance in record time.

Senior Global Product Manager, Semiconductor Chemical Mechanical Planarization (CMP) Division
Led product management and technical marketing of CMP products for metal films, identified new growth opportunities in a business unit with annual revenue >$950M.

Senior Program Manager, Corporate Strategic Marketing
Tracked and evaluated macro-economic and end-use environments to construct leading indicators for semiconductor industry cycles and developed semiconductor end-use demand models to forecast wafer and equipment demand. Solid performance identified to the Key-Contributor-Incentive-Plan

Education

Ph.D., Nonlinear Dynamics & Chaos, Mechanical Engineering, Cornell University, Ithaca, NY
- Nonlinear system identification and control of fluid-elastic vibrations using bifurcation theory.
- Award for outstanding research contribution, ASME-JSME joint conference, July 1998.

M.S., Mechanical Engineering, Cornell University, Ithaca, NY
B.Tech, Mechanical Engineering, Indian Institute of Technology, BHU, India

Patents:

1	20110198322	IN-LINE METROLOGY METHODS AND SYSTEMS FOR SOLAR CELL FABRICATION
2	20110139755	MULTI-WAVELENGTH LASER-SCRIBING TOOL

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Project Team Form

Team Member # 8 of 12	
Name of Individual	Sam Cowley
Position Title	Sr. Director, Product Management
Employer's Name and Address (street, city, and zip code)	Name: Solexel, Inc. Address: 1530 McCarthy Blvd. Milpitas, CA 95035
Individual's Phone Number and Email Address	Phone: 650-229-4735 Email: sam.cowley@solexel.com
Job Description	Mr. Cowley is responsible for product definition and market introduction. He interfaces with customers and market drivers to determine necessary features and guide internal product engineering teams to timely release of products. He works with field teams to install initial demonstrations of pre-commercial material.
Role and Responsibilities in the Proposed Project	Mr. Cowley will assist with the integration of the Solexel product into the project. He will collaborate with the engineering, procurement and construction resource to ensure that the product is installed correctly. He will assist in the commissioning and training of the team to accurately monitor and maintain the project.
Experience, Capabilities, and Credentials	Mr. Cowley has worked in solar for nine years, performing many field installations of new technologies. These include concentrated photovoltaic systems, building integrated systems and specialized products for customers. He has managed field teams and signed off on multiple demonstration and commercial projects.

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Project Team Form

Sam Cowley
sam.cowley@solexel.com
(650) 229 – 4735

1627 Tulane Dr
Mountain View, CA, 94040

Summary

Respected engineering leader with experience in multiple technical hardware fields. Familiar with the full product lifecycle from prototype to production to field support. Goal-driven, customer-focused team builder with strong communication skills.

Leadership

Direct management of engineering teams focused on system integration, design and test projects. Management of offshore development/production teams for product development. Led cross functional teams (marketing, operations and design) for design definition. Process development and optimization for solar, automation equipment and manufacturing cells. Brought multiple products (solar modules, telecom equipment) through certification cycles

Technical Design Experience

Electrical and mechanical design experience in fields including factory automation, telecom, optical transport, biotech and solar. Test stand and test process development for both mfg and engineering purposes. Field service utilities involving both hardware and software. Programming experience with Python, Visual Basic, .NET, C, C++, SQL, and Labview for embedded controllers, test stands and data analysis. Solar design expertise for consumer device, Concentrated PV and Building Integrated PV

Product Management

Market analysis experience on multiple products of performance, cost and features. Tool and documentation development to support sales and critical due diligence. Deep knowledge of solar from technology and business perspective

Employment History

Solexel, Inc. Senior Director of Product Management. *12/14 –present*

Responsible for product definition and market introduction. Interface with customers and market drivers to determine necessary features and guide internal product engineering teams to timely release of products. Areas of focus include glass plate PV modules, lightweight flexible BIPV and specialty products that harness Solexel high efficient, lightweight, shade tolerant technologies.

Alta Devices, Inc. Director of Product Engineering. *10/11 –12/14*

Led all technical engagements with customers in military, consumer, automotive and distributed generation markets. Main point of contact for these engagements. Coordinated product engineering team as well as other internal groups in projects to culminate in functional products, grant reports or internal development cycles. Developed marketing collateral based on product characterization for different segments and published papers to support findings. Built a variety of prototype products at various CM facilities to support customers as well as fundraising efforts.

Lumeta, Inc. Director of Product Management. *3/10 –10/11*

Completed technical definition of Lumeta BIPV product lines and certification through US and EU agencies. Drove external application development including wind uplift testing and alternate mounting support. Established worldwide field demo sites with partners for production monitoring. Developed relationships with suppliers and roof material companies to enable BIPV. Technical support for marketing and sales including webinars, white papers and bankability reports. Created energy yield, labor and financial models of product.

SolFocus Inc. Engineering Manager – System Integration and Test. *8/06 –3/10*
Created, staffed and led system integration group. System responsibilities included next generation product evaluation and selection, technical ownership of balance of system components (inverters, combiners, grounding, fuses, etc), process development for field installation and engineering response to all field issues. Test responsibilities included methodologies for prototype development and deployment of production test stands. Managed technical development of the SolFocus Tracker Controller and energy production models.

Harmonic Inc. Staff Integration and Test Engineer. *12/04 –5/06*
Technical lead on multiple new product development qualifications (optical and RF products). Duties include product evaluation, test stand design and implementation, coordination of qualification both on and off site. Helped develop new test framework to be used in automation of all testing provided from R&D to mfg as well as provided test solutions to mfg. Additional responsibilities included field use utilities and basic research into system interactions of product.

Onetta/Bookham. Integration Engineer. *2/01 –11/04*
Optical / technical lead on multiple new Erbium Doped Fiber Amplifier product developments including government contracts. Duties of this position include customer interaction on technical issues, technical coordination between design teams, prototype implementation and verification, development of test solutions (hardware and software) for use in manufacturing and significant documentation. Additional responsibilities included reliability testing (Telecordia), new component and vendor qualification, and sales support for demos and customer presentations.

Tycom Corporation. Project Engineer/Manager. *9/97 – 9/99* Designed, constructed and integrated automated solutions to manual tasks. Developed multiple robots in house and established a relationship with an outsourcing automation company to continue production. Additional duties included process qualification and optimization of deployed machines.

Education
Stanford University. MS in Electrical Engineering. June, 2001, Depth: Optical Systems
Additional sequences include Smart Product Design (ME218) and Integrated Design for Marketing and Manufacturing. Research Assistant LIGO project. Active suspension design team.

University of California at San Diego. BS in Mechanical Eng, June 1997

Additional Information
Missionary for The Church of Jesus Christ of Latter-day Saints, Sao Paulo, Brazil. *Nov '92-94*
Eagle Scout and adult leadership positions in Boy Scouts of America
Hobbies include tennis, snowboarding, waterskiing and car restoration.

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Project Team Form

Team Member # 9 of 12	
Name of Individual	Brendan Harney
Position Title	Senior Manager, Business Development
Employer's Name and Address (street, city, and zip code)	Name: Primus Power Address:3967 Trust Way, Hayward, CA 94545
Individual's Phone Number and Email Address	Phone:510.342.7636 Email:brendan.harney@primuspower.com
Job Description	Manage development of commercial, industrial and microgrid deployments
Role and Responsibilities in the Proposed Project	Project lead for integration of patented flow battery technology
Experience, Capabilities, and Credentials	Brendan Harney, Sr Manager of Business Development, leads commercial and industrial business development and marketing activity for Primus Power. Prior to Primus, Brendan led commercial market development at SolarCity. Brendan has a Masters from Georgetown University's School of Foreign Service and an MBA from Cambridge University.

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Brendan Harney
1826 Eddy Street, #202, San Francisco, CA 94115 - (917) 254 5633 - brendanharney@gmail.com

Experience

Primus Power Hayward, CA
Senior Manager, Business Development and Marketing March 2014 - Present

• Managing business development strategy and execution for behind-the-meter energy storage applications, including market analysis, lead generation, customer development, channel growth, sales and partnership strategy.

• Product manager for Primus Power's 30kW AC energy storage system.

• Project manager for Primus Power's 250kW /1MWh DC installation at MCAS Miramar in partnership with Raytheon.

• Managing all marketing, communication, and government relations activities for Primus Power.

SolarCity San Mateo, CA
Manager, Market Development / Structured Finance February 2012 – February 2013

• Led new commercial market development including primary and secondary market research, legislative analysis, lead generation, custom financial and tariff modeling, product positioning and partnership development.

• Designed and built a database of national utilities, customer demographics and applicable incentives for data-driven lead generation and pipeline development among the Fortune 1000.

• Developed national marketing campaign for sub-500kW commercial customers, working with SQL, Salesforce, GIS tools and SolarCity's proprietary software.

• Built financial models in support of $200 million in new tax equity financing from corporate and institutional investors.

• Managed pricing for all commercial and residential PV markets, directing asset management, software, sales operations and engineering. Competitive pricing analysis enabled 156MW (+$900mm) of bookings in FY2012 and 117% growth y/y.

International Energy Forum (IEF) Riyadh, Saudi Arabia
Energy Analyst September 2009 – September 2010

• Developed and executed a strategy to increase US government support of the IEF, an 86-member international energy organization created to further dialogue between energy producing and energy consuming nations, that led to the organization's first multi-year commitment of funds.

• Conducted energy and climate policy analysis, including the drafting of much of the IEF's current constitution.

• Built strong relationships with member energy ministries, industry CEOs and international organizations to increase the IEF's influence in energy policy and financial negotiations.

• Researched, edited and drafted much of the G20 commissioned report—*Biofuels: Potentials & Limitations* and the *Expert Group Report on the Producer-Consumer Dialogue and Energy Market Volatility*.

Center for Strategic and International Studies (CSIS) Washington, DC
Research Associate, Energy and National Security Program September 2008 – September 2009

• Authored *Why That Tank of Gas May Not Be Cheap for Long* on the credit crisis and a potential energy supply crunch.

• Contributed to the CSIS/WRI joint report *A Roadmap for a Secure, Low-Carbon Economy*, the conclusions of which were adopted by the Obama Administration in the formation of its climate and energy policies.

• Established and managed a conference attended by 120 lawmakers and industry experts on Smart Grid implementation and stimulus funding.

• Wrote and researched policy papers for senior fellows, including several White House briefings.

Daiwa Securities SMBC New York, NY
Vice President, Head of Specials Trading, Fixed Income August 2001 – April 2006

• Generated US$5.2m in P&L during abbreviated 2005 – 2006 fiscal year. Increased profitability of the Specials trading book fourfold. Primary manager for Fixed Income Division's daily trading activity with the Federal Reserve.

• Youngest Vice President in Daiwa NY history. Best P&L Performance in Daiwa NY Fixed Income Division.

Education

Cambridge University, Judge Business School Cambridge, UK. 2011
MBA – Cambridge MBA Scholarship
Co-President, Cambridge Energy & Environment Special Interest Group, CleanTech Challenge Captain
Internship: SunPower Corporation, Richmond, CA. Business Development—North American Commercial
Georgetown University, School of Foreign Service Washington, DC. 2009
MA (Honors) – GPA: 3.9; SSP Merit Scholarship
Internship: New Energy Finance, New York, NY. Summer Research Associate
Connecticut College New London, CT. 2001
BA – Economics

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Team Member # 10 of 12	
Name of Individual	Ravi Oswal
Position Title	VP Operations
Employer's Name and Address (street, city, and zip code)	Name: Primus Power Address:3967 Trust Way, Hayward, CA 94545
Individual's Phone Number and Email Address	Phone: 510 342 7600 Email:ravi.oswal@primuspower.com
Job Description	Lead manufacturing and installation for Primus Power
Role and Responsibilities in the Proposed Project	Will lead all supply chain and operational activity, including delivery of the EnergyPods and support
Experience, Capabilities, and Credentials	**Ravi Oswal**, VP Operations, is an operations and engineering executive who has demonstrated success across multiple technologies. He was an early employee at Bloom Energy where he helped build the operations infrastructure to support "Bloom Box", the company's distributed power-generation solution. During his nine-year tenure, he led diverse teams that drove fuel cell manufacturing, process engineering, supply chain, reliability, and quality, and managed integration across all functions to solve complex scaling challenges. Ravi holds a BS in Technology Chemical Engineering from the Indian Institute of Technology in New Delhi, and MS in Chemical Engineering from MIT.

Ravi Oswal
ravi.oswal@primuspower.com

Professional Summary

Operations and Engineering Executive with demonstrated success across multiple technologies and industries passionate about building the teams, processes and infrastructure of technology startups.

Professional Experience

Primus Power, VP, Operations, Electrical energy storage startup
Jan-14 to present

- Building the Operations team
- Leading the teams for new product introduction, supply chain management, manufacturing, and quality.

Bloom Energy, VP of Technical Operations, VP of Process and Quality Engineering
Mar-05 to Jan-14

- Early stage employee and member of executive team with this leading alternative energy startup that has developed the "Bloom Box", an affordable and reliable distributed power generation solution. Built the infrastructure and led the teams for Fuel Cell manufacturing, Process Engineering, Equipment Engineering, Supply Chain, Reliability, Quality and India Wholly Owned Entity. Led the integration across functions to solve technically complex scale-up challenges.
- As early member of executive team, helped build the company from a pre-revenue startup to an eminent enterprise positioned for billion dollar annual revenues
- Scaled up fuel cell stack (heart of the Bloom Energy product) manufacturing from prototype lab to a production facility with capacity of 30MW/year. Established production team, production system, technology, metrics, layout and flow. Decreased cycle time >75% and labor cost 90%VP Operations, Front End Products
- Developed "make vs. buy" strategy for stack manufacturing. Successfully executed outsourcing strategy to China, Taiwan, and Japan through volume ramp and met quality and cost targets Director of Software, Automation Technology
- Built the team and methodology for fuel cell Process Engineering and Equipment Engineering and drove yields from 25% to 75% in an environment of rapid technology insertions. Developed next generation manufacturing tools and processes to enable new products, high volume manufacturing, and quality improvement
- Established India operating entity using tax advantaged structures and served as Managing Director for 4 years. Recruited and retained world-class team of 90+ in a tough hiring market. Grew scope of operations from testing to product development, manufacturing, supply chain, modeling, and customer fleet remote monitoring

Telespree Communications, VP of Client Services and Operations
Jul-01 to Mar-05

- Built and led Software Deployment, Technical Support, QA, IT and HR teams for this venture-funded wireless "Over-The-Air" provisioning software startup. Joined at early stage and built a team for fast and flexible execution
- Established QA, IT, Professional Service teams and infrastructure. Managed facilities and HR outsourcing
- Reengineered operations strategy, processes and team through HW to SW strategy shift
- Deployed wireless telecom customers through interoperability testing, pilot trials, implementation and production support.

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Zoho Corporation, VP of Content and Customer Support Operations
Mar-99 to Jul-01

- Recruited by the Founders/Investors as the fourth employee to build and manage the team for IT, QA, Professional Services, Content Operations, and Customer Support for the startup online marketplace serving the hospitality industry
- Built website taxonomy, and content aggregation and capability including outsourcing at 50% cost reduction
- Developed Professional Service team and processes and managed implementation of strategic accounts

Raychem Corporation (Tyco Electronics)
Corporate Director of Enterprise Supply Chain Systems
1998-1999

- Managed $80 million worldwide SAP implementation with core team of 50 for $1.8 billion High Technology Materials company. Reengineered supply chain processes at plants and business operations in 12 countries

Director of Worldwide Operations, Commercial & Industrial Division
1994-1998

- Chief Operations executive for a $400 M/yr. manufacturer of electric heat tracing and corrosion protection products. Led a team of 500 in Production, Engineering, QA, Supply Chain, Product Management and Customer Service
- Guided product strategy and portfolio development and execution as member of an appointed executive team
- Reengineered manufacturing footprint and saved $9 million annually by moving plant from Belgium to Mexico. Centralized European support centers and saved $2M/yr. while improving service
- Implemented manufacturing cells and improved process technology to reduce cycle times 75% and increase yields from 80 to 95%

Director of Quality, Chemelex Electric Heat Tracing Division
1992-1993

- Invited to launch a major worldwide Total Quality Management process as a member of the executive team.
- Designed and implemented a TQM process based on Deming principles
- Awarded ISO 9001 certification and cited by independent auditors as best-in-class implementation

Various Engineering and Operations Management Roles, Chemelex Division 1980-1992

- Promoted through several positions of increasing responsibility to develop, introduce, scale up and manufacture new products, materials, and processes related to electrically active high performance polymers
- Improved cycle time by 50%, first pass yields by 15% and reduced unit cost 35%
- Implemented product-focused factory to support $30 million/year revenues and 25% annual growth
- Developed novel products, materials, and processes resulting in seven patents and $100M first year revenues

Education
Stanford University/AEA, “mini MBA” course on Managing High Technology Companies
MS Chemical Engineering • MIT
Bachelor of Technology Chemical Engineering • Indian Institute of Technology, New Delhi, India.

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Project Team Form

..Team Member # 11 of 12	
Name of Individual	Jonathan Hall
Position Title	VP Engineering
Employer's Name and Address (street, city, and zip code)	Name: Primus Power Address:3967 Trust Way, Hayward, CA 94545
Individual's Phone Number and Email Address	Phone: 510-342-7600 Email:jonathan.hall@primuspower.com
Job Description	Manage power conversion and software implementation
Role and Responsibilities in the Proposed Project	Lead engineering and testing of zinc bromine energy storage.
Experience, Capabilities, and Credentials	**Jonathan Hall**, VP Engineering, is an accomplished leader in advanced electromechanical technology development with expertise in EV powertrain, high precision actuation and control, and electricity generating micro turbines. Prior to joining Primus Power, he was a key member of several high performance teams including Tesla Motors, where Jonathan was an engineering manager and lead aspects of the Tesla Roadster drive motor, transmission, and the Lithium ion battery system. Prior to Tesla, he was a senior engineer and principal investigator on advanced motion control and active vibration cancellation systems at CSA Engineering (Moog Corp.) and Mevicon, Inc., and was a design engineer at Solo Energy Corp. Jonathan has a degree in Mechanical Engineering from San Jose State University and is author of several technical papers and patents.

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Jonathan Hall
jonathan.hall@primuspower.com

Professional Summary

A creative technical leader who excels at developing technologies via a passion for designing and building hardware and teams.

Professional Experience

Primus Power, VP of Engineering, Energy storage startup
Aug 2009 - *Present*

- Responsible for innovation and execution of flowing electrolyte battery product development
- Leading and building a world class cross-functional engineering group consisting of 25+ mechanical, chemical, electrical, and software engineering staff
- As the first engineering leadership hire, built the detailed battery design, in house fabrication facilities, test infrastructure, corporate IP generation program, etc. from scratch
- Drove design, construction, and development of all development systems from W scale to 20kW scale

Tesla Motors, Engineering Manager, Electric vehicle startup
Jan *2006 - Aug 2009*

- Engineering Manager, Battery Systems: Managed design and test engineering group to re-design and production launch high energy density Lithium Ion electric vehicle battery systems
- Engineering Manager, Transmissions: Managed an internal engineering team and outside design firms to develop two new designs for a single speed, highly efficient, cost optimized electric vehicle transmissions
- Release engineer for the world's first dual clutch, EV specific, electrohydraulic 2-speed transmission

Mevicon, Inc., Senior Engineer, Thin-film technology startup
Jul *2004 - Jan 2006*

- One of 3 key engineers who started company to develop thin film structures and electromechanical shape control technology with the goal of commercializing large aperture, very light weight optics systems

CSA Engineering, Project Engineer, Aerospace Structural Dynamics and Motion Control
Jun 2000-Jul 2004

- Principle Investigator and lead mechanical engineer for two programs which developed novel, 6-strutted parallel manipulator (hexapod), positioning systems for NASA and JPL
- Lead mechanical engineer in developing a very large and precise hexapod (2,500 lb payload & micron resolution) for a defense optics program, a new line of adjustable frequency tuned vibration dampeners, and other innovations

Solo Energy Corporation, Micro-turbine generator startup
May *1999 - Jun 2000*

- Designed systems for a catalytically fired "micro-turbine" generator technology for DG applications

Education

San Jose State University, CA, B.S. Mechanical Engineering, 2000
FAA Licensed Private Pilot, ASEL, Instrument Rated

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Patents

- US 8,092,081 B2: *Battery Thermal Event Detection System Using An Optical Fiber*
- US2010/0302051: *Battery Thermal Event Detection System Using A Thermally Interruptible Electrical Conductor*
- US 8,202,641 B2: *Metal Electrode Assembly For Flow Batteries*
- US 8,137,831 B1: *Electrolyte Flow Configuration for a Metal-Halogen Flow Battery*

Published Papers

- *Experimental Validation of Discrete Location Boundary Shape Control for Thin Film Shells*, 6th Gossamer Spacecraft Forum, Austin, Texas, April 18-21, 2005
- *Hexapods for Precision Motion and Vibration Control*, 2004, Co Author, American Society for Precision Engineering, Control of Precision Systems, Cambridge, MA, April 2004
- *Compact Lightweight Six-Axis Point-and-Hold Positioning System*, 2003, Paper #5054-33, Presented at the SPIE Conference on Industrial and Commercial Applications of Smart Structures Technology, San Diego, CA, March 2004
- *Dynamic Behavior of Thin Film Membrane Strips, 2002, Paper # AIAA-2002-1378, Presented at the AIAA 3rd Gossamer Spacecraft Forum, Denver, CO, April 2002*

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Team Member # 12 of 12	
Name of Individual	Charles H. Wells
Position Title	Industry Principal-Microgrids and Visiting Scholar at UCSD
Employer's Name and Address (street, city, and zip code)	Name:OSIsoft, LLC Address:777 Davis Street, San Leandro, CA 94577
Individual's Phone Number and Email Address	Phone:650 504 6278 Email:cwells@osisoft.com
Job Description	Lead company in development and implementation of energy efficient, control systems and smart grid technologies for use in power, water and energy.
Role and Responsibilities in the Proposed Project	Provide thought leadership in use of high speed (synchrophasors) data and modern control systems to improve the efficiency of power grids, water systems and other utility networks.
Experience, Capabilities, and Credentials	Has developed and presented new technology for event detection, oscillation mitigation control and Big Data Analytics using PMU data. Holder of six US Patents in Microgrid Control technology. For past 2.5 years has predominately on the microgrid controller at UCSD. Personally installed five operational PMUs on UCSD campus and currently installing 20 additional microPMUs funded by DOE ARPAe. In addition to being a well-known Subject Matter Expert specializing in power grids control, Dr. Wells has considerable experience designing and installing industrial control systems, including water and waste treatment systems. DSc in Electrical Engineering, MS Chemical Engineering and BS in Chemical Engineering. Registered Professional Engineer in Chemical Engineering and Control System Engineering in State of California.

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Project Team Form

Charles H. Wells, PE., Ph.D.
OSIsoft, UCSD Visiting Scholar
University of California San Diego
chuck.wells@mail.ucsd.edu
650-504-6278

EDUCATION:
Vanderbilt University, Chemical Engineering, B.E.
Washington University, Chemical Engineering, M.S.
Washington University, Electrical Engineering, D.Sc.

RESEARCH & PROFESSIONAL EXPERIENCE:
OSIsoft, LLC UCSD
Visiting scholar
2012-present

- Performs research in PMU applications and building energy efficiency systems.
- Instructed classes on how FFTs and Statistical Control theory can be used for real time oscillation detection and damping coefficient calculations from the peak amplitudes and corresponding methods of displaying spectral data.
- Extensive collaboration with Prof. Raymond de Callafon in on-line identification theory applied to grid dynamic modeling. Multiple joint presentations over past two years

OSIsoft, LLC
Industry Principle
2001-2012

- Specialized in WAMS systems. Designed and installed WAMS systems worldwide.
- Directed development of OSIsoft interfaces for PMUs (IEEE 1344 and C37.118) and the real time FFT interface.

Voith Automation Systems
Vice President Engineering 1995-2001

Electric Power Research Institute
Project Manager 1991-1995

Cadtrack
Vice President Engineering 1981-1991

Measurex Corporation
Engineer 1973-1981

Systems Control, Inc
Engineer 1968-1973

US Army- Nike-X Project Office

Captain 1966-1968

PUBLICATIONS:

- 8,498,752--- Decoupling controller for power systems:
- 8,457,912--- Unwrapping angles from phasor measurement units
- 7,961,112--- Continuous condition monitoring of transformers
- 7,755,371--- Impedance measurement of a power line
- 7,498,821--- Non-linear observers in electric power networks
- 7,490,013--- Power grid failure detection system and method

(1) "Energy storage monitoring and control for microgrids," C. Wells, K. Meagher, W. Torre, B. Washom, Electrical Energy Storage Applications and Technologies (EESAT), 2013 Conference, San Diego, CA Oct 20-25, 2013.

(2) "Continuum view of power grids using angle distance", C.H. Wells, Cigre 2013, June 2-5, 2013, Yekaterinburg, Russia, p2.1-2-12

(3) "Big Data Analytics at UCSD", C.Wells, IEEE Power and Engineering General meeting, Vancouver, BC. July 21-25, 2013.

(4) "Automatic Frequency and Damping Estimation in Ring-down Analyses," R. de Callafon and C.H. Wells, Joint Synchronized Information Subcommittee Meeting (WECC), January 15-16, 2013, Tempe, AZ.

(5) "A new method of identifying grid parameters from disturbance events," R. de Callafon and C. Wells, iPCGrid Conference, March 27, 2103, San Francisco.

(6) "WAMS Visualization using PI-Processbook," C. H. Wells, NASPI Phasor Tools VisualizationWorkshop, February 28, 2012, Tampa, FL. (see link for youtube videos)

(7) "Case Study: High Availability Secure Microgrid Monitoring System for UCSD", Power and Energy Automation Conference, SEL and Washington State University, March 26-28, 2013, Spokane, WA.

(8) "Solar microgrids to accommodate renewable intermittency," C.Wells, IEEE Transmission and Distribution general meeting, New Orleans, LA, April 19-22, 2010, Paper 978-1-4244-6547-7/10.

(9) "Detecting and Managing the Electrical Island created in the Aftermath of Hurricane Gustav using Phasor Measurement Units (PMUs)," F. Galvan and C, Wells, IEEE Transmission and Distribution general meeting, New Orleans, LA, April 19-22, 2010, Paper 978-1-4244-6548-7/10

SYNERGISTIC ACTIVITIES

Active participant in NASPI meetings (since its founding as the EIPP in December 2003). Active participant in WECC JSIS meetings. Personally installed WAMS systems in: Entergy (2005), China (2005), Tenaga (2006), Russia (2006), Mexico (2009), Ecuador (2011), Lead software designer of the PI System C37.118 interface, lead designer for the PI System IEEE 1344 PMU interface, Lead designer for the PI system FFT interface including real time damping coefficient calculations and additional error detection functions in the interface.

CURRENT AND PENDING SUPPORT

Consulting work is provided to Georgia Tech for their DOE funded Agent based distributed control system project.
Collaboration with following:
Prof M. Ilic Carnegie Mellon University
Prof M. Venkatasubramanian-Washington State University
Prof R. de Callafon University of California San Diego

ATTACHMENT 6
Scope of Work Template

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		System Architecture
3		Solar Integration
4	Yes	Flow-Battery Integration
5		Energy Management System
6	Yes	System Deployment and Commissioning
7		System Operation
8		Evaluation of Project Benefits
9		Technology/Knowledge Transfer Activities
10		Production Readiness Plan

B. Acronym/Term List

Acronym/Term	Meaning
BMS	Battery Management System
BES	Battery Energy System
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CCS	Combined Charging System
CPR	Critical Project Review
DR	Demand Response
EMS	Energy Management System
PV	Photovoltaic Solar Panel
TAC	Technical Advisory Committee

I. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this Agreement is to fund the integration, demonstration, and deployment of a community energy generation and storage system.

B. Problem/ Solution Statement

<u>Problem</u>

[1] Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

Current PV generation and BES activities do not adequately integrate the meter side community energy conditions and Utility DR functions. BES integrated energy management activities have the risk of potentially increasing peak demand and peak utility loads. Additional PV generation also increases generation uncontrolled by the utility. Unmanaged energy production and storage creates additional challenges for utility energy management and distribution.

Solution

This Project addresses all these concerns with the integration of BES and a closely linked community integrated Energy Management System. The community EMS will manage activities for BES and DR to minimize site energy charges associated energy use and peak demand. The advanced PV will be the first source to supply needed energy when energy costs peak. The BES will coordinate charging events when peak energy charges are not a risk. A properly integrated and configured EMS integrating BES and DR will supply the facility with reduced peak energy demand and a dispatchable energy source supporting utility initiated DR activities.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Demonstrate the facility and IOU ratepayer benefits of an EMS integrating advanced PV with BES;
- equip existing community center with 90kW of advanced PV generation and 60kWh of BES;
- integrate DR capabilities within the facility EMS to optimize between PV generation and BES;
- install and deploy system components and architecture at designated Community Center in Southern California Edison (SCE) territory to facilitate continued operation of the facility during power limited events;
- ensure system architecture, components, technology, and participants are commercially viable; and
- validate system operation, quantify electrical demand impacts, quantify emission offsets.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater electricity reliability and lower costs by managing energy use associated PV generation and BES during daily energy use profiles as well as DR events. The integration of proposed EMS components will reduce peak energy demand by utilizing BES to shift building and community loads. The reduction of peak energy requirements will reduce failures and outages associated with peak energy demands. The reduction of peak energy use will also reduce the costs associated with procuring additional energy during periods of peak demand. The proposed Project is scalable in

[2] California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC "Phase 2" Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).

both size and quantity. Therefore, this effort will demonstrate the commercial feasibility to deploy many MWh of dispatchable energy integrated in a PV/BES configuration.

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by integrating energy storage and PV technology. This Project architecture provides BES and PV technology integrated with EMS to support diurnal energy loads. This effort supports a more reliable and integrated California state energy system to manage loads and meet customer demands. This project will implement utility initiated DR functions and create an architecture that allows expansion to future power regulation and potential wholesale market participation.

Agreement Objectives

The objectives of this Agreement are to:

- The demonstration and deployment of pre-commercial PV generation and BES technologies.
- The enactment of innovative energy management strategies including, intermittent production, electric energy storage, targeted energy efficiency, demand management, and power interruptions.
- The deployment of community scale advanced PV generation and integrated BES strategies will successfully reduce peak energy demands, reduce peak power demand, and demand fluctuations. PV generation will offset daily peak energy and peak power demand during production hours while BES management will offset additional energy and power demands.
- The project will produce technical and economic performance data on PV generation innovative BES integration strategies. The documentation will include installation issues, operational constraints, operational performance, and impact on utility bills within the community.
- The challenges and barriers to deployment of community scale PV generation and innovative BES management strategies will be documented and presented. This will include integration with existing infrastructure, community financial and operational support, and regulatory collaboration.
- The optimal balance of generation resource and BES to reduce peak power and manage daily energy loads will be implemented with performance monitoring.
- Identification of the energy management strategies that provide the highest value with minimal negative impact. This project will develop and implement the best value between peak demand and daily community energy consumption.
- The project will provide, utility DR controlled dispatchable power to minimize the daily demand variations of the community and compensate for local variations outside the community.

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[3] California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

II. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V).** Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, **"days"** means working days.

The Recipient shall:

For products that require a draft version

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Submit the final product to the CAM once agreement has been reached on the draft. The CAM will provide written approval of the final product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- If the CAM determines that the final product does not sufficiently incorporate his/her comments, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For products that require a final version only

- Submit the product to the CAM for approval.
- If the CAM determines that the product requires revision, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For all products

- Submit all data and documents required as products in accordance with the following Instructions for Submitting Electronic Files and Developing Software:

    - **Electronic File Format**
      Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick or CD-ROM.

The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

- ***Software Application Development***
  Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:
  - Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
  - Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
  - Visual Studio.NET (version 2008 and up). Recommend 2010.
  - C# Programming Language with Presentation (UI), Business Object and Data Layers.
  - SQL (Structured Query Language).
  - Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
  - Microsoft SQL Reporting Services. Recommend 2008 R2.
  - XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting
The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:
- Attend a "Kick-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at

the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:
- Terms and conditions of the Agreement;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:
- The CAM's expectations for accomplishing tasks described in the Scope of Work;
- An updated Project Schedule;
- Technical products (subtask 1.1);
- Progress reports and invoices (subtask 1.5);
- Final Report (subtask 1.6);
- Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
- Any other relevant topics.

- Provide an *Updated Project Schedule, List of Match Funds,* and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:
- Designate the date and location of the meeting.
- Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:
- Updated Project Schedule *(if applicable)*
- Updated List of Match Funds *(if applicable)*
- Updated List of Permits *(if applicable)*

CAM Product:
- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings
The goal of this subtask is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Submit the CPR Report along with any other *Task Products* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 products along with the CPR Report).
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)
- Task Products (draft and/or final as specified in the task)

CAM Products:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

  The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.
  - The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
  - The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
    - Disposition of any state-owned equipment.
    - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
    - The Energy Commission's request for specific "generated" data (not already provided in Agreement products).
    - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
    - "Surviving" Agreement provisions such as repayment provisions and confidential products.
    - Final invoicing and release of retention.

- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Products:
- Final Meeting Agreement Summary *(if applicable)*
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices
The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:
- Submit a monthly *Progress Report* to the CAM. Each progress report must:
  - Summarize all Agreement activities conducted by the Recipient for the preceding month, including an assessment of the ability to complete the Agreement within

- the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
    - Provide a synopsis of the project progress, including accomplishments, problems, milestones, products, schedule, fiscal status, and any evidence of progress such as photographs.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the "Payment of Funds" section of the terms and conditions. In addition, each invoice must document and verify:
    - Energy Commission funds received by California-based entities;
    - Energy Commission funds spent in California *(if applicable)*; and
    - Match fund expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review and approve the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Recipient must use a Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM.
- Submit a draft of the outline to the CAM for review and comment.
- Once agreement has been reached on the draft, submit the final outline to the CAM. The CAM will provide written approval of the final outline within 10 days of receipt.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Style Manual

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline and the Style Manual provided by the CAM.
- Submit a draft of the report to the CAM for review and comment. Once agreement on the draft report has been reached, the CAM will forward the electronic version for Energy Commission internal approval. Once the CAM receives approval, he/she will provide written approval to the Recipient.

- Submit one bound copy of the Final Report to the CAM.

Products:
- Final Report (draft and final)

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds
The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:
- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

  If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:
  - A list of the match funds that identifies:
    - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
    - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
  - A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter *(if applicable)*
- Match Funds Reduction Notification Letter *(if applicable)*

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
    - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
    - The schedule the Recipient will follow in applying for and obtaining the permits.

  The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits *(if applicable)*
- Updated Schedule for Acquiring Permits *(if applicable)*
- Copy of each Approved Permit *(if applicable)*

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of the executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts *(draft if required by the CAM)*

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
  - Technical area expertise;
  - Knowledge of market applications; or
  - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;

- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:
- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:
- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings
The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

The Recipient shall:
- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Products:
- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

III. TECHNICAL TASKS

*Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

TASK 2 System Architecture

The goals of this task are to define and specify the energy management software and control algorithms capable of PV Generation, DR, and BES operations. Define physical data and power connections between system components.

The Recipient shall:

- Procure EMS..
- Develop algorithms for DR, PV Generation, and BES operations.
- Configure EMS for DR, PV Generation, and BES operations.
- Define physical data and power connections between system components.
- Develop and implement *Test Plan* for bi-directional charge/discharge operation.
- Prepare a *Software Report* in defining EMS system functions and operations.
- Create *Site Drawings* of physical system layout with communications.

Products:

- Software Report
- Site Drawings

TASK 3 Solar Integration

The goal of this task is to provision and integrate 90 kilowatt (kW) of advanced solar PV system components.

The Recipient shall:

- Procure PV system components: panels, racks, tracking platforms, wiring, cables, data monitoring, inverter, energy management system interface computer.
- Integrate PV system components at community location.
- Develop, implement, and test PV control algorithms.
- Develop and implement *Test Plan* for operation.

Products:

- Test Plan

TASK 4 Flow-Battery Integration

The goal of this task is to Provision and integrate 60 kilowatt hours (kWh) of Zinc Bromine Flow battery within BES platform with BMS and Inverter.

The Recipient shall:

- Procure BES system components: batteries, BMS, BES platform, wiring, cables, data monitoring, inverter, energy management system interface computer.
- Integrate BES system components within BES platform.

- Develop, implement, and test BES control algorithms.
- Develop and implement *Test Plan* for bi-directional charge/discharge operation.

Products:
- Test Plan
- CPR Report

TASK 5 Energy Management System
The goals of this task are to configure and implement energy management software and associated hardware. Implement DR, PV generation, and BES functions based on facility daily energy profile and projected energy use. Define communications and control algorithms and coordinate with utility and project partners for energy requirements.

The Recipient shall:
- Configure and complete *Test Plan* of EMS for DR, PV production and BES operations.
- Implement physical data connections within BES.
- Perform bi-directional charge/discharge operation of BES.
- Perform bi-directional charge/discharge operation of DR remotely with EMS messages.

Products:
- Test Plan

TASK 6 System Deployment and Commissioning
The goals of this task are to Install and deploy system components and architecture at Community Center facility in Southern California Edison (SCE) territory.

The Recipient shall:
- Configure and complete *Test* of installed complete system consisting of EMS, PV generation, and BES.
- Implement physical data connections between all components.
- Perform bi-directional charge/discharge operation of BES.
- Perform EMS control with varying levels of PV generation.
- Integrate building energy data stream of real time kW power.
- Integrate utility initiated DR functions
- Prepare a *CPR Report* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:
- Test Plan
- CPR Report

TASK 7 System Operation
The goals of this task are to operate and demonstrate the system in collaboration with PV generation, facility energy demands, and utility DR for at least 12 months while collecting system data..

The Recipient shall:

- Operate system for a minimum of 12 months.
- Collect and store system EMS operational data.
- Respond to system failure or shutdown and repair as necessary.
- Prepare an *Operational Report*.

Products:
- Operational Report

TASK 8 Evaluation of Project Benefits
The goal of this task is to report the benefits resulting from this project.

The Recipient shall:
- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:

  - o <u>For Product Development Projects and Project Demonstrations:</u>
    - Published documents, including date, title, and periodical name.
    - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
    - Greenhouse gas and criteria emissions reductions.
    - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
    - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
    - A discussion of project product downloads from websites, and publications in technical journals.
    - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
    - <u>Additional Information for Product Development Projects:</u>
      - Outcome of product development efforts, such copyrights and license agreements.
      - Units sold or projected to be sold in California and outside of California.
      - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
      - Investment dollars/follow-on private funding as a result of Energy Commission funding.
      - Patent numbers and applications, along with dates and brief descriptions.

    - Additional Information for Product Demonstrations:
        - Outcome of demonstrations and status of technology.
        - Number of similar installations.
        - Jobs created/retained as a result of the Agreement.

  - For Information/Tools and Other Research Studies:
    - Outcome of project.
    - Published documents, including date, title, and periodical name.
    - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
    - The number of website downloads.
    - An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
    - An estimate of energy and non-energy benefits.
    - Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
    - A discussion of project product downloads from websites, and publications in technical journals.
    - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

The Energy Commission may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Products:
- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 9 Technology/Knowledge Transfer Activities

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Recipient shall:
- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
  - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
  - A description of the intended use(s) for and users of the project results.

    - Published documents, including date, title, and periodical name.
    - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
    - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
    - The number of website downloads or public requests for project results.
    - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop on the results of the project.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Products:
- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

TASK 10 Production Readiness Plan

The goal of this task is to determine the steps that will lead to the manufacturing of technologies developed in this project or to the commercialization of the project's results.

The Recipient shall:
- Prepare a *Production Readiness Plan*. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product, and to its state of development. As appropriate, the plan will discuss the following:
    - Critical production processes, equipment, facilities, personnel resources, and support systems needed to produce a commercially viable product.
    - Internal manufacturing facilities, supplier technologies, capacity constraints imposed by the design under consideration, design-critical elements, and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
    - The estimated cost of production.
    - The expected investment threshold needed to launch the commercial product.
    - An implementation plan to ramp up to full production.
    - The outcome of product development efforts, such as copyrights and license agreements.
    - Patent numbers and applications, along with dates and brief descriptions.
    - Other areas as determined by the CAM.

Products:

- Production Readiness Plan (draft and final)

ATTACHMENT 6a
ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION AGREEMENTS
Exhibit A - Scope of Work Project Schedule UC

Agreement Term: 7-1-2015 to 7-31-2018
*Within this Scope of Work, **"days"** means working days. Changes to due dates must be approved in writing by the CAM, and may require approval by the Energy Commission's Executive Director or his/her designee.*

Task/ Subtask #	Task/Subtask Name	Meeting Name	Product(s)	Due Date
1	General Project Tasks			
1.1	Products			
1.2	Kick-off Meeting	Kick-off Meeting		[Date to be inserted by the CAM]
			Updated Project Schedule *(if applicable)*	7 days after determination of the need to update the documents
			Updated List of Match Funds *(if applicable)*	
			Updated List of Permits *(if applicable)*	
			CAM Product	
			Kick-off Meeting Agenda	7 days prior to the kick-off meeting
1.3	CPR Meeting	CPR Meeting #1		[Date to be inserted by the CAM]
		CPR Meeting #2 *(to be deleted by the CAM if inapplicable)*		[Same as above]
			CPR Report	15 days prior to the CPR meeting
			Task Product(s)	
			CAM Products	
			CPR Agenda	5 days prior to the CPR meeting
			List of Expected CPR Participants	
			Schedule for Providing a Progress Determination	15 days after CPR meeting
			Progress Determination	As indicated in the Schedule for Providing a Progress Determination
1.4	Final Meeting	Final Meeting		[Date to be inserted by the CAM; must be the last date in the schedule]
			Final Meeting Agreement Summary *(if applicable)*	7 days after the final meeting
			Schedule for Completing Agreement Closeout Activities	
			All Draft and Final Written Products	
1.5	Progress Reports and Invoices		Progress Reports	10 days after the first of each month
			Invoices	10 days after the first of each month or quarter
1.6	Final Report			
1.6.1	Final Report Outline		Draft Final Report Outline	2/28/2018
			Final Report Outline	As determined by the CAM
			CAM Product	
			Style Manual	At least **2 months** prior to the final report outline due date
			Comments on Draft Final Report Outline	10 days after receipt of the Draft Final Report Outline
			Approval of Final Report Outline	10 days after receipt of the Final Report Outline
1.6.2	Final Report		Draft Final Report	4/31/2018
			Final Report	6/29/2018
			CAM Products	

ATTACHMENT 6a
ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION AGREEMENTS
Exhibit A - Scope of Work Project Schedule UC

Task/ Subtask #	Task/Subtask Name	Meeting Name	Product(s)	Due Date
			Comments on Draft Final Report Outline	30 days after receipt of the Draft Final Report
1.7	Match Funds		Match Funds Status Letter	2 days prior to the kick-off meeting
			Supplemental Match Funds Notification Letter *(if applicable)*	10 days after receipt of additional match funds
			Match Funds Reduction Notification Letter *(if applicable)*	10 days after any reduction of match funds
1.8	Permits		Permit Status Letter	2 days prior to the kick-off meeting
			Updated List of Permits *(if applicable)*	10 days after determination of the need for a new permit
			Updated Schedule for Acquiring Permits *(if applicable)*	
			Copy of Each Approved Permit *(if applicable)*	7 days after receipt of each permit
1.9	Subcontracts		Draft Subcontracts *(if required by the CAM)*	As determined by the CAM
			Final Subcontracts	
1.10	Technical Advisory Committee (TAC)		List of Potential TAC Members	2 days prior to the kick-off meeting
			List of TAC Members	7 days after finalization of the TAC
			Documentation of TAC Member Commitment	7 days after receipt of the documentation
1.11	TAC Meetings	TAC Meeting #1		[Date to be inserted by the CAM]
		TAC Meeting #2 *(to be deleted by the CAM if inapplicable)*		[Same as above]
			Draft TAC Meeting Schedule	20 days after the kickoff meeting
			Final TAC Meeting Schedule	10 days after the first TAC meeting
			Draft TAC Meeting Agendas	20 days prior to each TAC meeting
			TAC Meeting Back-up Materials	
			Final TAC Meeting Agenda	7 days prior to each TAC meeting
			TAC Meeting Summaries	10 days after each TAC meeting

ATTACHMENT 6a
ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION AGREEMENTS
Exhibit A - Scope of Work Project Schedule UC

Task/ Subtask #	Task/Subtask Name	Meeting Name	Product(s)	Due Date
Technical Tasks				
2	System Architecture		Software Report	12/15/2015
			Site Drawings	12/15/2015
3	Solar Integration		Solar Test Plan	12/15/2015
			Solar Test Report	3/31/2016
4	Flow-Battery Integration		Flow-Battery Test Plan	12/15/2015
			Flow-Battery Test Report	3/31/2016
			CPR Report	3/31/2016
5	Energy Management System		EMS Test Plan	12/15/2015
			EMS Test Report	3/31/2016
6	System Deployment and		Deployment Test Plan	3/31/2016
			Deployment Test Report	6/30/2016
			CPR Report	6/30/2016
7	System Operation		Operational Report	9/29/2017
8	Evaluation of Project Benefits		Kick-off Meeting Benefits Questionnaire	7/15/2015
			Mid-term Benefits Questionnaire	[Date to be inserted by the CAM]
			Final Meeting Benefits Questionnaire	7/31/2018
9	Technology/Knowledge Transfer Activities		Draft Initial Fact Sheet	7/1/2015
			Final Initial Fact Sheet	8/3/2015
			Draft Final Project Fact Sheet	1/30/2018
			Final Project Fact Sheet	3/30/2018
			Draft Presentation Materials	3/30/2018
			Final Presentation Materials	7/31/2018
			Draft Technology/Knowledge Transfer Plan	3/30/2018
			Final Technology/Knowledge Transfer Plan	7/31/2018
			Draft Technology/Knowledge Transfer Report	3/30/2018
			Final Technology/Knowledge Transfer Report	7/31/2018
10	Production Readiness Plan		Draft Production Readiness Plan	3/30/2018
			Final Production Readiness Plan	7/31/2018

ATTACHMENT 7

Summary Task Budget		Prime Recipient Reimbursable Costs	Major Subcontractor #1 Reimbursable Costs	Major Subcontractor #2 Reimbursable Costs	Major Subcontractor #3 Reimbursable Costs	Major Subcontractor #4 Reimbursable Costs	Major Subcontractor #5 Reimbursable Costs	Commission Reimbursable Totals	Match Funding Totals	Grand Totals
		University of California, Riverside				N	N			
	Company Types * :	DVBE SB MB None	DVBE SB MB None	DVBE SB MB None	DVBE SB MB None		D M	D M		
1.0	General Project Tasks	$ 103,556.00						**$ 103,556.00**	**$ 3,800.00**	**$ 107,356.00**
2.0	System Architecture	$ 155,334.00						**$ 155,334.00**	**$ 88,800.00**	**$ 244,134.00**
3.0	Solar Integration	$ 595,448.00						**$ 595,448.00**	**$ 132,315.00**	**$ 727,763.00**
4.0	Flow-Battery Integration	$ 647,226.00						**$ 647,226.00**	**$ 132,316.00**	**$ 779,542.00**
5.0	Energy Management System	$ 362,447.00						**$ 362,447.00**	**$ 95,000.00**	**$ 457,447.00**
6.0	System Deployment and Commissioning	$ 77,667.00						**$ 77,667.00**	**$ 87,000.00**	**$ 164,667.00**
7.0	System Operation	$ 284,780.00						**$ 284,780.00**	**$ 41,467.00**	**$ 326,247.00**
8.0	Evaluation of Project Benefits	$ 155,334.00						**$ 155,334.00**	**$ 53,000.00**	**$ 208,334.00**
9.0	Technology/Knowledge Transfer Activities	$ 103,557.00						**$ 103,557.00**	**$ 44,000.00**	**$ 147,557.00**
10.0	Production Readiness Plan	$ 103,557.00						**$ 103,557.00**	**$ 29,000.00**	**$ 132,557.00**
	Grand Totals	**$ 2,588,906.00**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,588,906.00**	**$ 706,698.00**	**$ 3,295,604.00**

PLEASE SEE THE INSTRUCTIONS SHEET FOR DETAILED INFORMATION ON COMPLETING THIS FORM.
If the budget forms are not filled out completely your bid/proposal may be rejected.

For these boxes, be sure to include all costs: labor (unloaded rates) and non-labor costs (fringe, overhead, general & administrative, and other direct operating costs).

NOTE: Cells will highlight red if the following conditions are not satisfied: Prime Recipient and Major Subcontractor Grand Totals must match the same totals in Att B-2; Match Funding Grand Totals must match those in Att B-2 and Att B-6; Project Grand Total must match that on B-2.

(*) Indicate which of these categories apply to each prime and subcontractor by selecting the appropriate checkboxes. The categories are Disabled Veteran Business Enterprise (DVBE), certified Small Business (SB), and Micro-Business (MB). Refer to the Instructions page for explanation and definition of each company type.

ATTACHMENT 7
Exhibit B
Att B-2 Category Summary

Summary Category Budget	Prime Recipient Reimbursable Costs	Major Subcontractor #1 Reimbursable Costs	Major Subcontractor #2 Reimbursable Costs	Major Subcontractor #3 Reimbursable Costs	Commission Reimbursable Totals	Match Funding Totals	Grand Totals
	University of California, Riverside	$ -	$ -	$ -			
Direct Labor	$ 595,938.00				**$ 595,938.00**	**$ 42,556.00**	**$ 638,494.00**
Fringe Benefits	$ 309,678.00				**$ 309,678.00**	**$ 8,736.00**	**$ 318,414.00**
Travel	$ 34,000.00				**$ 34,000.00**		**$ 34,000.00**
Equipment	$ 171,240.00				**$ 171,240.00**		**$ 171,240.00**
Materials/ Misc.	$ 807,378.00				**$ 807,378.00**	**$ 13,336.00**	**$ 820,714.00**
Minor Subcontractors*	$ 328,000.00				**$ 328,000.00**	**$ 629,247.00**	**$ 957,247.00**
Total Direct	**$ 2,246,234.00**	**$ -**	**$ -**	**$ -**	**$ 2,246,234.00**	**$ 693,875.00**	**$ 2,940,109.00**
Indirect Overhead					**$ -**	**$ 12,823.00**	**$ 12,823.00**
General & Administrative	$ 342,672.00				**$ 342,672.00**		**$ 342,672.00**
Profit**					**$ -**		**$ -**
Total Indirect	**$ 342,672.00**	**$ -**	**$ -**	**$ -**	**$ 342,672.00**	**$ 12,823.00**	**$ 355,495.00**
Grand Total	**$ 2,588,906.00**	**$ -**	**$ -**	**$ -**	**$ 2,588,906.00**	**$ 706,698.00**	**$ 3,295,604.00**
Amount of funds to be Spent in California***	**$ 2,588,906.00**				**$ 2,588,906.00**		
Percentage of Funds to be spent in California	**100.00%**				**100.00%**		

ATTACHMENT 7

University of California, Riverside

Time intervals from the start of the project through the Contract Term End Date. (Use your organization's Fiscal Year start / end dates.)		Projected Hourly Unloaded Rates ($)* <If Contractor is a UC or DOE entity, salary identified will be unloaded Monthly>					
		From: 7/1/15 To: 6/30/16	From: 7/1/16 To: 6/30/17	From: 7/1/17 To: 6/30/18	From: 7/1/18 To: 6/30/19	From: To:	
Name	Job Classification/Title	($) Unloaded Maximum Rate	($) Unloaded Maximum Rate	($) Unloaded Maximum Rate	($) Unloaded Maximum Rate	($) Unloaded Maximum Rate	Total Hours Worked
Martinez-Morales, Alfredo	Asst. Research Engr.	$ 8,350.00	$ 8,684.00	$ 9,031.36	$ 9,392.61		2210
Barth, Matthew	Professor	$ 17,175.00	$ 17,862.00	$ 18,576.48	$ 19,319.54		495
Nanpeng Yu	Asst. Professor	$ 7,735.00	$ 8,044.40	$ 8,366.18	$ 8,700.82		941
Ula, Sadrul	Research Engineer	$ 11,853.00	$ 12,327.12	$ 12,820.20	$ 13,333.01		1232
Todd, Michael	Development Engineer	$ 7,875.00	$ 8,190.00	$ 8,517.60	$ 8,858.30		1232
TBN	Graduate Students	$ 3,738.00	$ 3,887.52	$ 4,043.02	$ 4,204.74		8101

ATTACHMENT 7

University of California, Riverside							
Percentage Rates for Non-Labor Categories*							
Time intervals from the start of the project through the Contract Term End Date. (Use your organization's Fiscal Year start / end dates.)				**Fringe Benefits (FB)**	**Indirect Overhead (IOH)**	**General & Administrative (GA)**
From:	7/1/15	To:	6/30/16	50.00%		25.00%
From:	7/1/16	To:	6/30/17	62.00%		25.00%
From:	7/1/17	To:	6/30/18	54.00%		25.00%
From:	7/1/18	To:	6/30/19	54.00%		25.00%
From:		To:				

Base Calculation for Non-Labor Categories									
Non-Labor Rate Category	Check the budget expense items to which the indirect costs or fees are applied. Use the following abbreviations: DL = Direct Labor, FB = Fringe Benefits, M = Materials/ Miscellaneous, EQ = Equipment, T = Travel, S = Subcontracts, IOH = Indirect Overhead, GA = General & Administrative								
	Base Calculation	DL	M	EQ	T	S	FB	IOH	GA
Fringe Benefits	DL	☑	☐	☐	☐	☐			
Indirect Overhead		☐	☐	☐	☐	☐	☐		☐
General & Administrative	DL+M+T+S+FB	☑	☑	☐	☑	☑	☑	☐	
Additional Notes**	<This section is for Government Entities Only>								

Items Included in Non-Labor Categories		
List **items** you include in each non-labor category (e.g., vacation, 401K plan, telephone, rent/lease, insurance). **Clearly describe** each item. **Do not**: (1) use vague descriptions; (2) use acronyms; (3) use "etc.", "for example", or "such as"; (4) repeat items within columns; or (5) include rate calculations. If an explanation of an item is required, include it in a footnote. Some items may be **prohibited**, such as: (1) food; (2) beverages; and (3) printing expenses other than in-house expenses. Please refer to the following federal cost principles for guidance regarding allowable expenses: 48 Code of Federal Regulations (CFR) Chapter 1, Subchapter E, Part 31, Subpart 31.2 (commercial organizations) and 2 CFR Part 200, Subpart E (Sections 200.400 et. seq.) (state and local governments, Indian tribes, institutions of higher education, and nonprofit organizations).		
Fringe Benefits	Indirect Overhead	General & Administrative
Vacation		Indirect is charged on all project
Holidays		costs except student tuitioin and fee,
Graduate Student Researcher		equipment, and the cost of subcontracts
tuition and fees		in excess of the first $25,000.
Worker's Comp		The indirect supports University
		administrative costs that cannot be
		directly charged to the project including
		general facilities charges, general
		charges to support accounting, personnel,
		and payroll, etc. This is a special rate
		for State of California agencies.

PLEASE SEE THE INSTRUCTIONS SHEET FOR DETAILED INFORMATION ON COMPLETING THIS FORM.
If the budget forms are not filled out completely your bid/proposal may be rejected.

(*) Actual billable rates cannot exceed the rates specified in this exhibit.
(**) Additional Notes apply to Government Entities Only. In this section, enter any additional comments on base calculations and overhead. For example: if FB is applied to only the first $25K of a subcontract, then you should select the Subcontract box for Fringe Benefits, and make a note in the Additional Notes section indicating that this applies only to the first $25K.

NOTE: If the Base Calculation cells turn red, you have entered an invalid circular reference between IOH and GA. IOH is used as a base for GA, which is in turn used as a base for IOH. This will invalidate the budget workbook. Do not proceed if the Base Calculation cells are highlighted red.

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ATTACHMENT 7

Pre-approved Travel List *							
						Amount	
Task No.	Prime / Sub Name	Trip #	Who	Departure and Destination	Trip Purpose	Commission Funds	Match Funds
1	UCR	*1*	*PI*	Riverside/Sacramento	Kickoff Meeting	$ 1,333.00	$ -
1	UCR	*2*	*PI*	Riverside/Sacramento	CPR Meeting	$ 1,333.00	$ -
1	UCR	*3*	*PI*	Riverside/Sacramento	Final Meeting	$ 1,334.00	$ -
7-Feb	UCR	*4-n*	*All UCR personnel*	Riverside-Chemehuevi	Site visits	$ 30,000.00	$ -
					Total:	$ 34,000.00	$ -

* Travel is reimbursed at state rates.

Equipment**							
						Amount	
Task No.	Prime / Sub Name	Description	Purpose	# Units	Unit Cost	Commission Funds	Match Funds
3	UCR	PV system inverter	Integrate solar with grid	1	$ 60,000.00	$ 60,000.00	$ -
4	UCR	Flow battery inverter	Integrate flow battery	1	$ 111,240.00	$ 111,240.00	$ -
					Total:	$171,240	$0

** Equipment is defined as having an acquisition unit cost of at least $5,000. See instructions for more details.

Material(s)/ Miscellaneous Costs							
						Amount	
Task No.	Prime / Sub Name	Description	Purpose	# Units	Unit Cost	Commission Funds	Match Funds
2	UCR	Hardware and software	System design for operation a	1	$ 85,000.00	$ 85,000.00	$ -
3	UCR	Electrical contractor	Install/integrate solar system	1	$ 98,000.00	$ 98,000.00	$ -
4	UCR	Electrical contractor	Install/integrate battery syste	1	$ 98,000.00	$ 98,000.00	$ -
4	UCR	ical contractor	Flow battery installation	1	$ 98,000.00	$ 98,000.00	$ -
1-10	UCR	CE-CERT facilities charges	Facilities rental direct charge	1	$ 369,714.00	$ 356,378.00	$ 13,336.00
4	UCR	Engineering flow battery	Engineer the battery and its in	1	$ 72,000.00	$ 72,000.00	$ -
					Total:	$ 807,378.00	$13,336

Minor Subcontractors							
			Company Types *			Amount	
Task No.	Subcontractor Legal Name	Purpose	DVBE	SB	MB	Commission Funds	Match Funds
3	Congenra Solar	Electrical installation				$ 99,000.00	$ 25,000.00
3	Solexel	Electrical installation				$ 80,000.00	$ 12,000.00
4	Primus Power	Electrical components, design, integration				$ 99,000.00	$ 21,780.00
2-10	OSISoft	Software, design, installation, integration, monitoring, analysis, tech transfer				$ 50,000.00	$ 479,467.00
2-10	Chemehuevi	Demo site				$ -	$ 91,000.00
					Total:	$328,000	$629,247

PLEASE SEE THE INSTRUCTIONS SHEET FOR DETAILED INFORMATION ON COMPLETING THIS FORM.
If the budget forms are not filled out completely your bid/proposal may be rejected.

NOTE: Cells will highlight red if the following conditions are not satisfied: Pre-approved Travel totals must be less than or equal to those in Att B-2; Equipment, Material(s)/Miscellaneous Costs, and Minor Subcontractors totals must equal those in Att B-2; In Equipment and Material(s)/Miscellaneous sections, the amounts listed under Commision Funds and Match Funds must add up to the product of the Unit # and Unit Cost - **rounded up to the nearest whole dollar** - for each item. For example, if an equipment item is listed with 3 units and a $1.50 unit cost, then the Commission and Match Funds listed for this item must add up to $5.00. 3 x $1.50 = $4.50, which rounds up to $5.00.

(*) Indicate which of these categories apply to each minor subcontractor by selecting 'Yes' from the dropdown menu. If the category does not apply, you may either select 'No' or leave it blank. The categories are Disabled Veteran Business Enterprise (DVBE), certified Small Business (SB), and Micro-Business (MB). Refer to the Instructions page for explanation and definition of each company type.

ATTACHMENT 7

Task Match Funding Budget		Match Contributor #1	Match Contributor #2	Match Contributor #3	Match Contributor #4	Match Contributor #5	Match Contributor #6	Match Funding Totals
	Contributor Name:	University of California, Riverside	Cogenra Solar	Solexel	OSIsoft	Chemehuevi Indian Tribe	Primus Power	
1.0	General Project Tasks	$ 3,800.00						**$ 3,800**
2.0	System Architecture	$ 3,800.00			$ 80,000.00	$ 5,000.00		**$ 88,800**
3.0	Solar Integration	$ 17,925.00	$ 12,500.00	$ 6,000.00	$ 80,000.00	$ 5,000.00	$ 10,890.00	**$ 132,315**
4.0	Flow-Battery Integration	$ 17,926.00	$ 12,500.00	$ 6,000.00	$ 80,000.00	$ 5,000.00	$ 10,890.00	**$ 132,316**
5.0	Energy Management System	$ 10,000.00			$ 80,000.00	$ 5,000.00		**$ 95,000**
6.0	System Deployment and Commissioning	$ 2,000.00			$ 60,000.00	$ 25,000.00		**$ 87,000**
7.0	System Operation	$ 2,000.00			$ 4,467.00	$ 35,000.00		**$ 41,467**
8.0	Evaluation of Project Benefits	$ 8,000.00			$ 35,000.00	$ 10,000.00		**$ 53,000**
9.0	Technology/Knowledge Transfer Activities	$ 8,000.00			$ 35,000.00	$ 1,000.00		**$ 44,000**
10.0	Production Readiness Plan	$ 4,000.00			$ 25,000.00			**$ 29,000**
	Grand Totals	**$ 77,451**	**$ 25,000**	**$ 12,000**	**$ 479,467**	**$ 91,000**	**$ 21,780**	**$ 706,698**

PLEASE SEE THE INSTRUCTIONS SHEET FOR DETAILED INFORMATION ON COMPLETING THIS FORM.
If the budget forms are not filled out completely your bid/proposal may be rejected.

NOTE: Cells will highlight red if the following conditiones are not satisfied: The Match Funding Grand Total must equal those from Att B-1 and Att B-2.

ATTACHMENT 7

Company		DL+FB	Total Indirect	DL+FB+Total Indirect	(DL+FB)/(DL+FB+Total Indirect)
Prime	University of California, Riverside	$ 905,616.00	$ 342,672.00	$ 1,248,288.00	0.725486426
Major Sub #1	0	$ -	$ -	$ -	
Major Sub #2	0	$ -	$ -	$ -	
Major Sub #3	0	$ -	$ -	$ -	
Major Sub #4	0	$ -	$ -	$ -	
Major Sub #5	0	$ -	$ -	$ -	
Major Sub #6	0	$ -	$ -	$ -	
Major Sub #7	Company Name	$ -	$ -	$ -	
Major Sub #8	Company Name	$ -	$ -	$ -	
Major Sub #9	Company Name	$ -	$ -	$ -	
Major Sub #10	Company Name	$ -	$ -	$ -	
Major Sub #11	Company Name	$ -	$ -	$ -	
Major Sub #12	Company Name	$ -	$ -	$ -	
Major Sub #13	Company Name	$ -	$ -	$ -	
Major Sub #14	Company Name	$ -	$ -	$ -	
Major Sub #15	Company Name	$ -	$ -	$ -	
		$ 905,616.00	$ 342,672.00	$ 1,248,288.00	0.73

Average Team (DL+FB)/(DL+FB+Total Indirect)	0.725
Team Score (Out of 5)	3.627

ATTACHMENT 8
California Environmental Quality Act (CEQA) Compliance Form

1. **What are the physical aspects of the proposed activities? (Check all that apply and provide a brief description of work, including the size or dimensions of the project).**

Type of Project	Yes	No	Project Description
Construction (including grading, paving, etc.)		D	The project includes installation of two solar systems and a flow battery.
Trenching		D	Trenching for conduits to the inverters and qrid
New or replaced pipelines	D		
Modification or conversion of a facility		D	Installation of equipment and hardware for monitoring, data collection and control.
New or modified operation of a facility or equipment		D	Installation of equipment and hardware for monitoring, data collection and control.
On-road demonstration	D		
Paper study (induding analyses on economics, feedstock availability, workforce availability, etc.)		D	Modeling and analysis of expected/actual energy and cost savings.
Laboratory research		D	Modeling and analysis of expected/actual energy and cost savings.
Temporary or mobile structures (skid-mounted)	D		
Design/Planning		D	The project includes installation of two solar systems and a flow battery.
Other (describe and add pages as necessary)	D		

2. **Where are the proposed activities located or where will they be located? (Attach additional sheets as necessary.)**

Street Address	City/ County	Type of Work to Be Completed at Site
1978 Valley Mesa **Rd.**	Havasu Lake/San Bernardino	Installation of two solar systems, one flow-battery, equipment and hardware for monitoring, data collection and control. Demonstration site.

3. **Will the proposed activities potentially have environmental impacts that trigger CEQA review? (Check a box and explain for each question.)**

Question	Yes	No	Unsure	Explanation
Is the project site environmentally sensitive?	D		D	
Is the project site on agricultural land?	D		D	
Is this project part of a larger project?	D		D	
Is there public controversy about the proposed project or	D		D	

ATTACHMENT 8
California Environmental Quality Act (CEQA) Compliance Form

Question	Yes	No	Unsure	Explanation
larQer project?				
Will historic resources or historic buildings be impacted by the project?	D		D	
Is the project located on a site the Department of Toxic Substances Control and the Secretary of the Environmental Protection have identified as being affected by hazardous wastes or cleanup problems?	D		D	\
Will the project generate noise or odors in excess of permitted levels?	D		D	
Will the project increase traffic at the site, and by what amount?	D		D	

4. Will the proposed activities require discretionary permits or determinations, as listed below?

Type of Permit	No.	Modified	New	Approvi ng Public Agency	Reason for Permit, Summary of Process, and Antici pated Date of Issuance
Air Quality Permit		D	D		
Water Quality Permit		D	D		
Conditional Use Permit or Variance		D	D		
Building Expansion Permit		D	D		
Hazardous Waste Permit		D	D		
RezoninQ		D	D		
Authority to Construct		D	D		
Other Permits (List types)		D	D		

5. Of the agencies listed in #4, have you identified and contacted the agency that will be the lead CEQA agency on the project?

D Yes. Provide the name of and contact information for the lead agency.

ATTACHMENT 8
California Environmental Quality Act (CEQA) Compliance Form

No. Explain why no contact has been made, and/or a proposed process for making contact with the lead agency.

The Demonstration Site is under the Jurisdiction of the Chemehuevi Indian Tribe. They will responsible for reviewing and approving this project

6. **Has any agency listed in #4 prepared environmental documents (e.g., Notice of Exemption, Initial Study/Negative Declaration/Mitigated Negative Declaration, Environmental Impact Report, Notice of Determination) under CEQA for the proposed project, or indicated that it will prepare such documents?**

D **Yes.** Provide the name of and contact information for the agency.

Please complete the following and attach the CEQA document to this worksheet. (For "Not a project," the title of the document may be an e-mail, resolution, or letter).

Type of Environmental Review	**Title of Environmental Document**	**State Clearinghouse Number**	**Completion Date**	**Planned Completion Date (must be rior to a roval of award)**
"Not a project"		N/A		N/A
Exempt (Resolution of public agency or Agenda Item approving Exemption)		N/A		N/A
Exempt (Notice of Exemption)		N/A		
Initial Study				
Negative Declaration				
Mitigated Negative Declaration				
Notice of Preparation				
Environmental Impact Report				
Master Environmental Impact Report				

ATTACHMENT 8

California Environmental Quality Act (CEQA) Compliance Form

Type of Environmental Review	**Title of Environmental Document**	**State Clearinghouse Number**	**Completion Date**	**Planned Completion Date (must be rior to a roval of award)**
Notice of Determination				
NEPA Document (Environmental Assessment, Finding of No Significant Impact, and/or Environmental Impact Statement)[8]				

No. If any of the agencies identified in #4 have indicated that they will prepare CEQA documents , explain why no document has been prepared. Propose a process for obtaining lead agency approval and the estimated date for that approval (must occur before the Energy Commission will approve the award).
No environmental documents will be necessary.

Certification: I certify to the best of my knowledge that the information contained in this form is true and complete. I further certify that I am authorized to complete and sign this form on behalf of the proposing organization.

Name: Ursula Prins

Title: Princj nt Officer

Signature:

Phone Number: 951-827-4808

Email: ursula.rns edu

Date: /2015

[8] For additional information about NEPA (the National Environmental Policy Act, 42 U.S.C. 4321 et seq.), see: http://www.epa.gov/compliance/basics/nepa.html.

ATTACHMENT 9
Reference and Work Product Form

1. Section One: References

Identify **three** references for the recipient and **two** for each subcontractor, using the table below for each reference. Use additional pages as needed. References must be current (within the past three years). Please ensure that contact information is current.

☒	☐
Name of Recipient/ Subcontractor	University of California, Riverside
Name of Reference Firm/Organization	South Coast Air Quality Management District
Address (city, state, and zip code)	21865 East Copley Dr, Diamond Bar, CA 91765
Contact Name and Title	Al Baez, Program Supervisor
Contact Phone Number and Email Address	Phone Number: (909) 396-2516 Email: abaez@aqmd.gov
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Design, implement and build a testbed consisting of 4 MW solar PV, 2.2 MWh Lithium battery energy storage, several level II electric vehicle chargers and an electric passenger trolley. This is a unique UC-Riverside's Sustainable Integrated Grid Initiative (SIGI) facility with real world electric utility scale capabilities.

☒	☐
Name of Recipient/ Subcontractor	University of California, Riverside
Name of Reference Firm/Organization	California Institute for Energy & Environment University of California
Address (city, state, and zip code)	2087 Addison St, Berkeley, CA 94704
Contact Name and Title	Ken Krich
Contact Phone Number and Email Address	Phone Number: (510) 643-5542 Email: ken.krich@uc-ciee.org
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	On site testing and evaluation of HVAC motors in commercial and industrial building. Efficiency calculations. Developing a 25 hp motor testing facility with training for utility and industry practitioners.

ATTACHMENT 9
Reference and Work Product Form

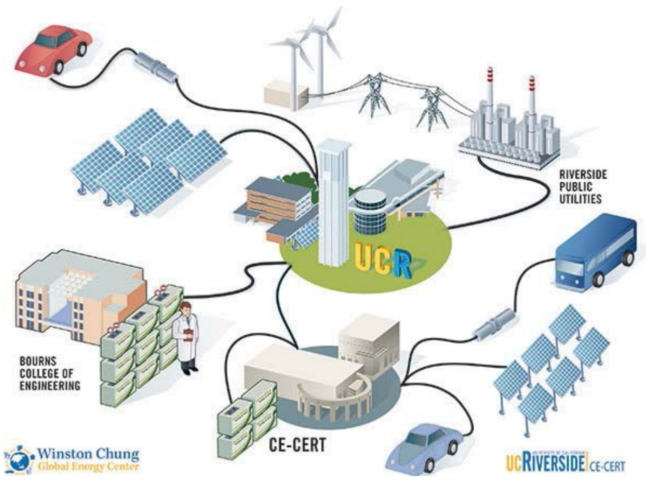
☒	☐
Name of Recipient/ Subcontractor	University of California, Riverside
Name of Reference Firm/Organization	South Coast Air Quality Management District
Address (city, state, and zip code)	21865 East Copley Dr, Diamond Bar, CA 91765
Contact Name and Title	Al Baez, Program Supervisor
Contact Phone Number and Email Address	Phone Number: (909) 396-2516 Email: abaez@aqmd.gov
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	This project targets the evaluation and demonstration of advanced charging technologies and associated vehicle activity to demonstrate the effectiveness of PEV deployment as part of a smartgrid system. PEV utilization is greatly increased by incorporating advanced charging strategies and/or technologies. This project incorporates and evaluates different PEV charging methods and vehicle activity analysis into the UCR New Grid test-bed, including: V2G, LDEV DC fast charging, and HDEV DC fast charging.

ATTACHMENT 9
Reference and Work Product Form

Work Product Past Project 1

Project Title: Sustainable Integrated Grid Initiative (SIGI)

Integrated Energy Management System (EMS) strategies, control software, and energy management have been demonstrated by UC Riverside (Figure 1) in their Sustainable Integrated Grid Initiative (SIGI, see http://www.cert.ucr.edu/sigi) smart microgrid deployment. PES systems have also been created and deployed by the project partners (Winston Energy and UC Riverside) with appropriate Battery Management Systems (BMS) and system control.



- **4 MW of PV Solar Generation**
- **2.08 MWh of Battery Energy Storage**
- **Distribution feeder monitoring**
- **26 Level 2 EV Charger monitoring**
- **EV Transit 28 passenger trolley bus**
- **Level 3 Fast DC charging**
- **Energy monitoring of generation, storage, facility usage, and supply**
- **Demand management and utility coordinated management strategies**

Figure 1. UC Riverside's SIGI microgrid system architecture and components, see http://www.cert.ucr.edu/sigi for more details.

This project harnesses the expertise of those at the forefront of: energy storage, energy management, power regulation and conditioning, demand response, and microgrids. The effort and expertise of the project partners will be combined to create an integrated energy system capable of DR with the flexibility to implement a wide variety of energy management strategies. The project participants have previously demonstrated technological feasibility in their respective fields of expertise. This project facilitates the integration of multiple parties' expertise into a single microgrid implementation.

This integrated energy management project will demonstrate the feasibility of:

Smart Charging- monitor meter side facility demand, PES SOC status, BESS SOC status, diurnal utility demand, and DR requests to actively manage demand load.

Demand Response – participate in DR program and integrate DR functions with the energy management system. Curtailment of building load, PES and BESS charging activity during DR curtailment requests will be possible.

Portable Energy Storage to Grid – provide PES energy from the batteries to the meter side of the grid during periods of high facility demand or grid demand. Integrate functions to minimize peak energy charges for facilities demand. PES can supply power during DR curtailment requests.

This project will be implemented at CE-CERT, which is a center dedicated to conducting multidisciplinary engineering R&D for over 22 years. As described above, the CE-CERT team recently successfully implemented a South Coast Air Quality Management District (SCAQMD) funded project with EVs, battery storage, and solar photovoltaics. The total value of the project is about $8 million including matching contributions from the partners. The UCR team members have also completed numerous federal, state and industry funded projects on intelligent transportation, ride sharing, drive motor energy efficiency, and EV research and development.

Overall, the UCR CE-CERT team has extensive experience and capabilities in conducting fundamental research, testing, validation, field demonstration and deployment of novel technologies over a period of 22 years. As mentioned above, the New Grid project involved the design, permitting, construction and deployment of 2.2 MWh Lithium BESS, 500 kW of solar PV and multiple EVs. The team successfully navigated through permitting and regulatory hurdles of deployment of these newer technologies at the off-campus research park located in an industrial zone.

Furthermore, the SIGI project has already demonstrated and provided relief to the Riverside Public Utilities during the recent peak historic demand, as shown below in Figure 2. In September 14, 2014, the triple digit temperatures lead to RPU reaching a new all-time high electricity demand of 610 megawatts (MW). In the days to follow RPU send out an appeal to larger customers to conserve electrical energy, specifically between 2 pm to 5 pm. In response, CE-CERT's SIGI Testbed provided the flexibility to not only curtail the nominal power consumption of 365 kW from the three CE-CERT buildings, but also provided 225 kW back to the grid, resulting in a 590kW swing for three hours, as shown below.

- CE-CERT Admin building net energy savings: 95 kW
- CE-CERT APL building net energy savings: 180 kW
- CE-CERT CAEE building net energy savings: 315 kW

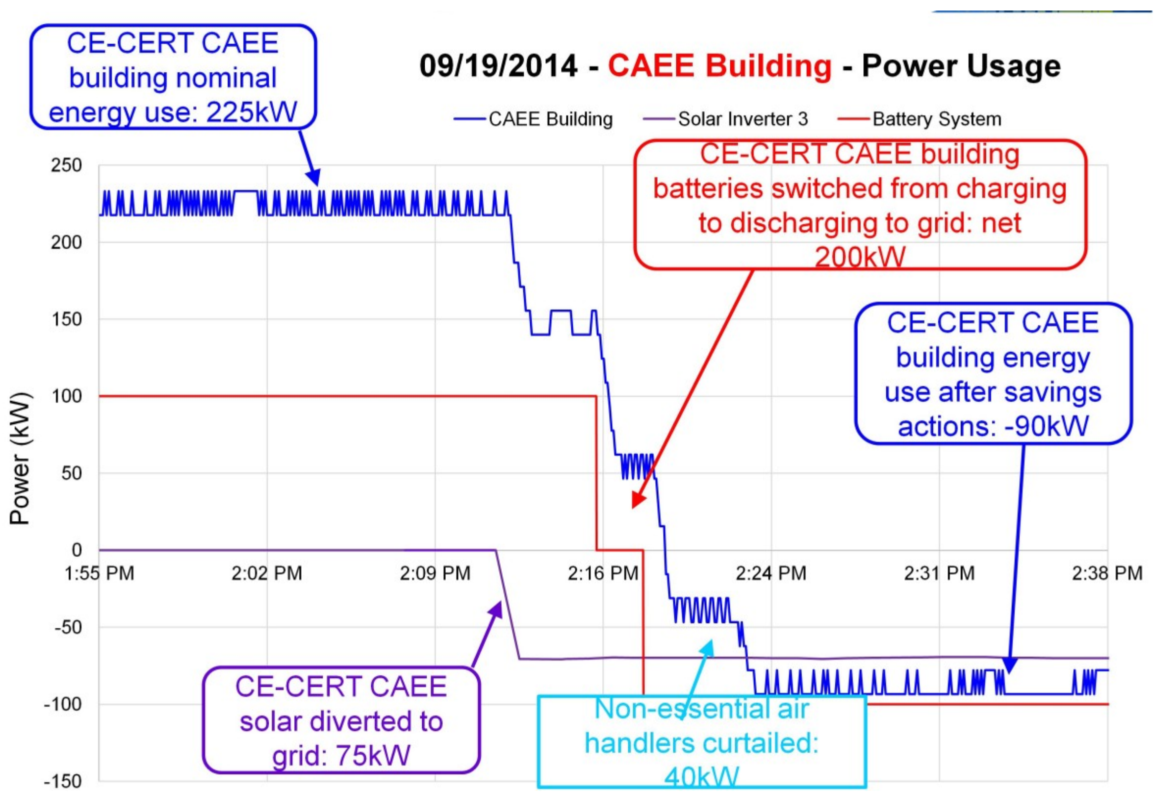


Figure 2. SIGI's demonstrated DR capability (CE-CERT CAEE Building).

ATTACHMENT 9
Reference and Work Product Form

2. Section One: References

Identify **three** references for the recipient and **two** for each subcontractor, using the table below for each reference. Use additional pages as needed. References must be current (within the past three years). Please ensure that contact information is current.

☐	☒
Name of Recipient/ Subcontractor	Cogenra Solar
Name of Reference Firm/Organization	Advanced Research Projects Agency - Energy
Address (city, state, and zip code)	Advanced Research Projects Agency - Energy U.S. Department of Energy 1000 Independence Avenue, S.W. Washington, D.C. 20585
Contact Name and Title	Brian Borak, Support Contractor to ARPA-E
Contact Phone Number and Email Address	202.287.5465
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Cogenra is contracted to work with ARPAe as a prime on one project and as a sub on another project currently.

☐	☒
Name of Recipient/ Subcontractor	Cogenra Solar
Name of Reference Firm/Organization	California Energy Commission
Address (city, state, and zip code)	1516 Nineth Street, MS 29 Sacramento, CA 95814
Contact Name and Title	Mohammad Hassan
Contact Phone Number and Email Address	(919) 327 1442 hmohamme@energy.state.ca.us
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Cogenra is currently working on PIER grant for higher efficiency receiver development. The project is going ahead of schedule and very successfully.

ATTACHMENT 9
Reference and Work Product Form

Work Product Past Project 2

Project Title: Solar Cogeneration of Electricity and Hot Water at DoD Installations

Cogenra Solar, Inc. set out to demonstrate an innovative hybrid electric/thermal solar cogeneration system at Port Hueneme (Naval Base Ventura County) and the Parks Reserve Forces Training Area (PRFTA) (Dublin, CA), validate and document performance and cost advantages, and develop financing models and engineering tools to expedite transfer of the technology widely across DoD facilities.

Cogenra's approach combines proven PV and SHW technologies into a single integrated solar cogeneration system that extracts as much of the sun's incident power as possible as high-value electricity and delivers the rest as useful heat. Cogenra's SunDeck solar collectors are water-cooled concentrating PV (CPV) parabolic troughs that capture rather than dissipate what other PV approaches call "waste heat." The architecture comprises a series of ground or roof-mounted arrays that independently track the sun along one axis. Within each array, a series of flat mirrors concentrate sunlight (~8X) onto silicon-based PV-Thermal (PVT) panels that generate electricity. Conduits in the receiver panel carry a water-glycol mixture in a closed loop that cools the PV cells, enhancing their performance, and captures the excess solar energy as heat. A compact SHW heat exchange/storage system transfers the heat to preheat the domestic water supply before it enters the site's pre-existing hot water heater.

The demonstration project included the installation of Cogenra systems at five separate buildings; three at Port Hueneme and two at PRFTA. The electricity and thermal energy delivered by these systems was measured for one year, and the systems continue to operate. The project set out to demonstrate that compared to standard PV and SHW arrays of the same size, Cogenra's system:

1) Generates at least 4.75X as much renewable energy (electricity + heat)
2) Delivers 2X the economic value
3) Reduces GHG emissions by 2.6X vs. PV and by 1.3X vs. SHW
4) Pays back the initial investment in energy cost savings in less time
5) Can accelerate compliance with DoD energy and environmental goals ~2X
6) Requires minimal operation and maintenance, comparable to PV and SHW

The SunDeck demonstration systems performed well and delivered over 4X as much renewable energy as a reference PV array, 1.7X the economic value as a reference PV array, and 1.4X the value of a reference SHW array. These gains were somewhat less that the stated performance goals, primarily due to inconsistent hot water usage in some of the buildings, especially the barracks. Similarly, the Cogenra systems demonstrated greater GHG emissions reduction than PV or SHW, though slightly less than the target due to system utilization. Low or inconsistent hot water demand limits the utilization of the cogeneration system overall, but especially the amount and value of the heat delivered. When there is low demand for the thermal energy collected by the solar array, the solar thermal storage tank heats up and eventually reaches its upper temperature limit, which triggers the array to de-track to avoid overheating. When de-tracked the array produces neither electricity nor hot water, impacting the economics of the project. In cases where hot water demand is inadequate, Cogenra's system architecture can instead be configured to cheaply dissipate some or all of the captured heat.

Lifecycle cost analysis demonstrated that the Cogenra systems offer a payback period of 5.1 years, ½ to ⅔ the payback time of PV or SHW. The results of the project demonstrated the increased value of cogeneration, enabling accelerated and cost-effective compliance with the DoD's energy and environmental goals. Operation and maintenance requirements have been similar to PV or SHW and the systems continue to operate successfully.

ATTACHMENT 9
Reference and Work Product Form

3. Section One: References

Identify **three** references for the recipient and **two** for each subcontractor, using the table below for each reference. Use additional pages as needed. References must be current (within the past three years). Please ensure that contact information is current.

☐	☒
Name of Recipient/ Subcontractor	Primus Power
Name of Reference Firm/Organization	Puget Sound Energy
Address (city, state, and zip code)	10885 N.E. 4th Street Bellevue, WA 98004-5591
Contact Name and Title	Patrick Leslie
Contact Phone Number and Email Address	Patrick.leslie@pse.com, 888-225-5773
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Primus Power, a leader in grid-scale electrical energy storage, is partnering with the Bonneville Power Administration (BPA) to deliver and support two 250 kW EnergyPods™ as part of a research and demonstration project under BPA's Technology Innovation Program. PSE is studying the potential installation of grid-scale flow batteries in the electric distribution network of PSE, an investor-owned, regulated utility that provides electric and natural gas service to customers within BPA's transmission and balancing territory.

☐	☒
Name of Recipient/ Subcontractor	Primus Power
Name of Reference Firm/Organization	Modesto Irrigation District
Address (city, state, and zip code)	1231 11th Street Modesto, CA 95354
Contact Name and Title	Martin Caballero, Director
Contact Phone Number and Email Address	Martin.Caballero@mid.org, (209) 526-7337
Describe the services or products the Recipient/subcontractor provided to the reference	Primus Power is deploying a 25MW/75MWh EnergyFarm™ in the Modesto Irrigation District (MID) in California' central valley that consists of an array of 250kW EnergyPods™; plug-and-play zinc-flow battery modules and power electronics systems housed inside ISO

firm/organization.	shipping containers. The modular design and operation will be field tested at Pacific Gas & Electric with support from Sandia National Laboratories and the Electric Power Research Institute. The 25MW EnergyFarm™ will support MID's efforts to balance increasing amounts of renewable generation and more efficiently manage its fleet of generating assets to meet peak loads. The system will likely be deployed incrementally in multiple substations and provide additional benefits such as local-area voltage stability and deferral of substation upgrades.

ATTACHMENT 9
Reference and Work Product Form

Work Product Past Project 3

Project Title: Puget Sound Energy

PSE's Winslow and Murden Cove substations on Bainbridge Island, outside Seattle, were projected to reach their maximum capacity of 58MW in 2015 while some of the island's ratepayers connected through those substations were experiencing an average of one transmission and twenty distribution outages a year.

Efforts to slow load growth on Bainbridge Island had not been as successful as PSE had hoped and the cost of building an additional 25 MVA substation, a proposal which faced significant opposition from the local community and City Council, was estimated at $10.5 million. Commercial and residential customers were unhappy with the number of outages but those closest to the potential upgrade sites protested that an additional transmission line or substation would reduce their property values and increase health risks.

BPA and PSE worked with Primus Power to design an energy storage solution that provided the greatest economic value to PSE ratepayers with the smallest environmental and physical footprint—the EnergyPod. Due to its high power density, PSE and Primus were able to site the EnergyPod at an existing substation with no additional land requirements. To determine the optimal battery size, PSE conducted an analysis of the top ten peak energy days from the preceding six years which determined that THREE HOURS OF ENERGY STORAGE could address 90% of the peak events on Bainbridge Island. Tie-in for the EnergyPod was determined after outage study on each distribution feeder illustrated the point of interconnection that would offer outage protection by islanding the greatest number of customers.

PSE decided on two Primus Power EnergyPods, equal to 500kW – 1MWh of energy storage, sited inside the Murden Cove substation and tied to the WIN-12 circuit.

Distribution Upgrade Deferral

Installation of the Primus battery allows PSE to defer investment in an additional substation on Bainbridge Island for nine years, saving PSE $6.3 million.

Outages

PSE valued outage reduction at $10 million, the net present value of the benefits to ratepayers on the circuit served by the Primus battery. The benefit to ratepayers allows PSE to rate base its investment in Primus energy storage technology.

Capacity Services

The Primus battery would also be eligible for capacity payments. A comparative analysis found that the capacity value for the Primus battery would equal $1,697/kW or $142/kW/year. PSE modeled system-wide load forecast data to determine when the battery would be needed for capacity services and valued the capacity services potential at $7 million.

ATTACHMENT 9
Reference and Work Product Form

☐	☒
Name of Recipient/ Subcontractor	OSIsoft LLC
Name of Reference Firm/Organization	San Diego Gas & Electric (Sempra Utilities)
Address (city, state, and zip code)	100 Ash Street San Diego CA 92101
Contact Name and Title	Enrique Villalobos
Contact Phone Number and Email Address	619-696-2273 evillalobos@semprautilties.com
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	SDG&E has used the PI System from OSIsoft as a data infrastructure at commercial scale and as an enabling technology in many of their innovative programs and pilot projects.

☐	☒
Name of Recipient/ Subcontractor	OSIsoft LLC
Name of Reference Firm/Organization	Peak Reliability (PeakRC)
Address (city, state, and zip code)	7600 NE 41st Ave, Suite 150 Vancouver, WA 98662
Contact Name and Title	Andrew Esselman Application Support Analyst (PI)
Contact Phone Number and Email Address	360-713-9059 aesselman@peakrc.com
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	The PI System is used to collect and store high speed synchrophasor data used by PeakRC to ensure reliability of the western grid. The PI System is also used for real-time situational awareness.

ATTACHMENT 9
Reference and Work Product Form

☐	☒
Name of Recipient/ Subcontractor	Solexel, Inc.
Name of Reference Firm/Organization	Surek PV Consulting
Address (city, state, and zip code)	Denver, CO 80246
Contact Name and Title	Dr. Tom Surek
Contact Phone Number and Email Address	303-332-8506, tom_surek@yahoo.com
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Dr. Surek has evaluated Solexel technology for investors and partners. He was previously the manager of the NREL PV program.

☐	☒
Name of Recipient/ Subcontractor	Solexel, Inc.
Name of Reference Firm/Organization	Was Department of Energy – Michael left in Oct 2014 for the private sector
Address (city, state, and zip code)	Washington, DC 20585
Contact Name and Title	Mr. Michael Cliggett
Contact Phone Number and Email Address	(703) 483-2000, michaelcliggett@gmail.com
Describe the services or products the Recipient/subcontractor provided to the reference firm/organization.	Mike Cliggett was the program administrator for the Department of Energy while Solexel was participating in the Sunshot program.

Battery Management and Application for Energy-Efficient Buildings

Tianshu Wei* Taeyoung Kim* Sangyoung Park† Qi Zhu*
Sheldon X.-D. Tan* Naehyuck Chang† Sadrul Ula* Mehdi Maasoumy§
*University of California at Riverside
†Seoul National University
§C3 Energy

ABSTRACT

As the building stock consumes 40% of the U.S. primary energy consumption, it is critically important to improve building energy efficiency. This involves reducing the total energy consumption of buildings, reducing the peak energy demand, and leveraging renewable energy sources, etc. To achieve such goals, hybrid energy supply has becoming popular, where multiple energy sources such as grid electricity, on-site fuel cell generators, solar, wind, and battery storage are scheduled together to improve energy efficiency.

In this work, we focus on the application and management of battery storage for energy-efficient buildings. We will first introduce a system-level approach to co-schedule the usage of battery storage (in addition to grid electricity) with the control of building HVAC (heating, ventilation, and air conditioning) system, to reduce the total building energy cost, including the electricity consumption charge, the peak demand charge, and the battery cost. Then, in a separate formulation, we will introduce another system-level study to reduce the energy cost of EV charging and other fixed building energy load through the usage of battery storage and solar PV. Finally, we will present an ARM processor based programmable embedded battery management system (BMS), which monitors battery status, controls charging and discharging at the circuit level, and provides battery protection. The system also works with off-the-shelf battery management IC (Texas Instrument BMS sensor IC) from industry. Comparing to conventional BMS, this software module based BMS is a more suitable solution for energy-efficient buildings due to its high flexibility, scalability, and reusability.

We will introduce an industrial building testbed with battery storage and solar PV at the University of California, Riverside, and present initial field tests and simulation results for above approaches.

1. INTRODUCTION

The commercial and residential building stock consumes 40% of the U.S. primary energy consumption, 40% of the greenhouse gas emissions, and 70% of the electricity use [6]. Improving building energy efficiency is therefore critically important to address the nation's energy and environmental concerns. To achieve this goal, hybrid energy supply is being adopted, where multiple energy sources are scheduled together to improve the energy efficiency by reducing the peak demand and leveraging renewable energy sources such as solar and wind. In this work, we focus on the usage of battery storage, in addition to grid electricity, to improve the building energy efficiency. We will address the problem from both the system level, by proposing approaches to utilizes batteries for reducing the total energy cost, and from the circuit level, by developing an advanced battery management system (BMS) to monitor, control and protect the batteries.

At the system level, energy-efficient smart buildings today employ sophisticated and distributed building management systems. As the brain of modern buildings, the building management system controls many aspects of the building operations including heating, ventilation and air conditioning (HVAC), lighting, fire and security, electric vehicle (EV) charging, etc. In particular, HVAC system accounts for 50% of the building energy consumption, and the control of it is critical for building energy efficiency. The demand side scheduling of HVAC control depends on the availability of battery storage and the price of grid electricity, and the supply side scheduling of battery storage requires the knowledge of the HVAC demand. Therefore, we believe it is essential to ***address these two aspects in an integrated framework to achieve the maximal energy efficiency***. In particular, it is important to address the management and application of battery storage together with HVAC scheduling. In the literature, various HVAC control mechanisms [14, 23, 22, 7, 21, 20, 13, 24] are proposed for reducing energy consumption and cost. There are also approaches proposed for efficiently scheduling multiple energy sources [9, 15, 16, 19, 11]. However, there has been little work on formulating the interactions between the two aspects and addressing them together. Furthermore, most of the HVAC control work in the literature are either based on simulation results without validations through field tests, or more focused on feasibility demonstration in the field and not the optimal design of the control algorithm. In this work, we propose a novel system-level algorithm for the building management system to ***co-schedule the HVAC control with the usage of battery storage system*** and grid electricity to reduce the building energy cost, including both the electricity consumption charge and the peak demand charge, as introduced in Section 2. The algorithm is based on model predictive control (MPC) and leverages the battery model from the battery management system in Section 4.

We also conduct studies on utilizing battery storage, together with solar PV and grid electricity, to reduce the en-

DAC'14, June 01 – 05 2014, San Francisco, CA, USA.

http://dx.doi.org/10.1145/2593069.2596670.

ergy cost for EV charging and other fix building energy load (i.e., assuming all energy loads are given and no co-scheduling is conducted). As an emerging building application, EV charging is becoming a major load on the demand side (especially in residential buildings).

At the circuit level, we develop a software module based BMS that monitors the battery status, controls charging and discharging of the battery, and provides battery protection. The BMS computes and indicates state of charge (SOC), remaining capacity, and state of health (SOH). These measurements will be used at the system level to control the scheduling of the battery storage.

We use the building testbed at the Center for Environmental Research and Technology (CE-CERT) in University of California, Riverside (UCR) to identify energy saving opportunities, provide proper simulation parameters, and ultimately implement and evaluate our approaches through field tests. The building testbed is an administrative building (1084 Columbia Ave) at the UCR CE-CERT center, which is located off campus in an industrial zone. It pays standard industrial electrical time of use rates which includes peak and off demand charges. The building HVAC system consists of 16 packaged rooftop units, each with its own control interface. Over the last 18 months, we have installed additional measuring and control instruments for the HVAC system. To implement our MPC-based control algorithm that controls and coordinates the 16 rooftop units, a programmable controller is deployed, which can continuously monitor the real-time energy demand, and send control commands to the 16 units. The building testbed is also integrated with the following infrastructure and facilities available in the UCR CE-CERT center: 1) 0.5MW solar PV on car ports connected through three separate inverters to three CE-CERT buildings, including the building testbed, 2) 0.54 MWh Lithium-ion battery storage connected with three buildings including the testbed, 3) 0.54 MWh Lithium-ion mobile battery storage, 4) multiple L2 charger and one L3 charger for EV charging.

Next, we introduce our approach for co-scheduling HVAC control and battery usage for energy cost reduction in Section 2. We present our study on using battery storage to reduce energy cost for EV charging and fixed building loads in Section 3. We present our BMS design in Section 4. Finally, Section 5 concludes the paper.

2. CO-SCHEDULING OF HVAC CONTROL AND BATTERY USAGE

To reduce building electricity energy cost, there are two main portions of the electric bill that we are able to control – the total amount of the electricity used, measured in kWh, and the peak demand of electricity, measured in kW. As an example, for our testbed building, in the month of June 2013, the peak demand charge was $758.75, with a peak demand at 72.4 kW and billed at $10.48 per kW. The HVAC usage peaks around 65kW (the remaining 7.4kW of usage comes from other loads such as lighting and computers). The electricity consumption charge is $2,390.82. Based on these numbers, a 20% peak HVAC demand reduction will amount to more than 4% reduction in total electricity energy cost. We also reviewed the electric bills for another two larger buildings in CE-CERT. Those buildings use high demand rate schedule, and the peak HVAC demand charge has an even higher percentage in the total electricity cost (25% - 30%). It is clear that shaving the peak demand alone can bring significant reduction in building energy cost.

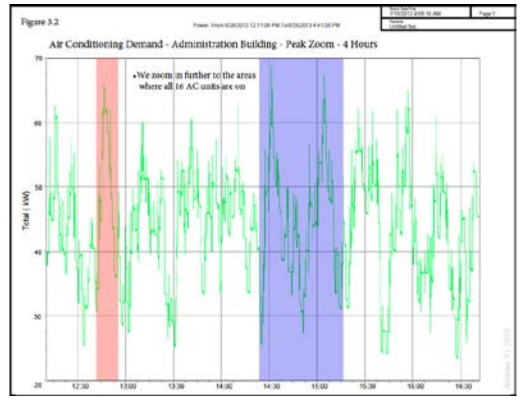


Figure 1: HVAC demand variations during peak hours (collected on the building testbed).

To investigate the peak shaving potential from the HVAC system, we conducted initial data collection and testing on our building testbed. Fig. 1 shows the peak hour (12pm to 5pm) HVAC demand of our testbed building we collected on June 28, 2013. It is clear that even within the peak hours, there are significant variations on the HVAC demand – the peak demand reaches almost 70kW when most of the AC units are turned on, while the low demand is below 30kW when only a few of the them are on. By moving ahead or delaying some of the AC units demand, we should be able to shave the peak significantly while still maintaining the temperature within the comfort zone for building occupants.

In below, we propose a MPC-based algorithm to minimize the total electricity cost, including the electricity consumption charge, the peak demand charge, and the battery overuse cost. First, Table 1, 2 and 3 summarize the notations of various parameters and variables.

Variables	Definition
$b1, b2, b3, b4, b5$	battery model coefficients [10]
p_b	unit cost of battery
$SOC(t)$	state of charge
C_b	capacity of battery
R_b	internal resistance
E_b	battery lower threshold
p_{bo}	battery overuse cost
$B(t)$	battery residual electricity
C_i	battery charging current

Table 1: Notations of battery parameters

Variables	Definition
$c1, c2, c3, c4$	energy coefficients [12]
AC_p	AC power
$U_{upBound}$	air flow upper bound
$U_{lowBound}$	air flow lower bound
U_N	nominal voltage of AC

Table 2: Notations of HVAC parameters

Variables	Definition
$p_g(t)$	electricity price
p_p	peak power charge
$T_{upBound}(t)$	comfort zone upper bound
$T_{lowBound}(t)$	comfort zone lower bound
$Tctrl$	room states
$u(t)$	air flow
$e_g(t)$	electricity from power grid
$e_b(t)$	electricity from battery
$charge(t)$	power grid charges battery

Table 3: Notations of variables and constrains

The MPC formulation is as follows. Equations (2), (3) and (4) encode the temperature updates and constrains. Equations (5) and (6) compute the energy consumption based on airflow and set up energy constraints. Equation (7) is a constrain on HVAC air flow. Equation (8) is the open circuit voltage of battery, and (9) is the residual electricity in battery. Equations (10) and (11) are battery energy constrains. Equations (12) and (13) are battery charging constrains.

$$\min \sum_{t=j}^{j+w-1} \Big[p_g(t)e_g(t) + p_b e_b(t) + [E_b + e_b(t) - B(t)]^+ p_{bo} \Big] \tag{1}$$

$$+\max\{e_g(t)\}p_p + p_g(t)charge(t)$$

$$Tctrl(t+1) = An \cdot Tctrl(t) + Bn \cdot u(t) + En \cdot distMPC(t) \tag{2}$$

$$T_{lowBound}(t+1) \le C_n Tctrl(t+1) \tag{3}$$

$$C_n Tctrl(t+1) \le T_{upBound}(t+1) \tag{4}$$

$$e = (c_1 \cdot u(t)^3 + c_2 \cdot u(t)^2 + c_3 \cdot u(t) + c_4)AC_p/100 \tag{5}$$

$$e_g(t) + e_b(t) \ge e, e_g(t) \ge 0, e_b(t) \ge 0 \tag{6}$$

$$U_{lowBound} \le u(t) \le U_{upBound} \tag{7}$$

$$V_{OC}(t) = b_1 e^{b_z SOC(t)} + b_3 SOC(t)^3 + b_4 SOC(t)^2 + b_5 SOC(t) + b_6 \tag{8}$$

$$B(t) = SOC(t) C_b U_N \tag{9}$$

$$e_b(t) \le B(t) \tag{10}$$

$$e_b(t) \le U_N V_{oc}(t)/R_b/1000 \tag{11}$$

$$0 \le charge(t) \le U_N C_i/1000 \tag{12}$$

$$charge(t) \le B(t) - E_b \tag{13}$$

$$SOC(t+1) = SOC(t) - e_b(t)/U_N/C_b \tag{14}$$

We conduct a set of simulations to evaluate the effectiveness of above algorithm for co-scheduling HVAC control with battery usage. The simulation parameters are chosen based on the building testbed. We simulate 24 hours of operation and set the predicting window of the MPC to 8 hours.

First, Fig. 2 shows the electricity consumption during each hour provided by the power grid when grid is the only available energy resource. To keep temperature within the comfort zone, the electricity consumption from 9:00 to 15:00 is very high. According to the time-of-use electricity price offered by utility companies, this period of time is also during peak hours. Such consumption profile results in high electricity consumption charge and also high peak demand charge.

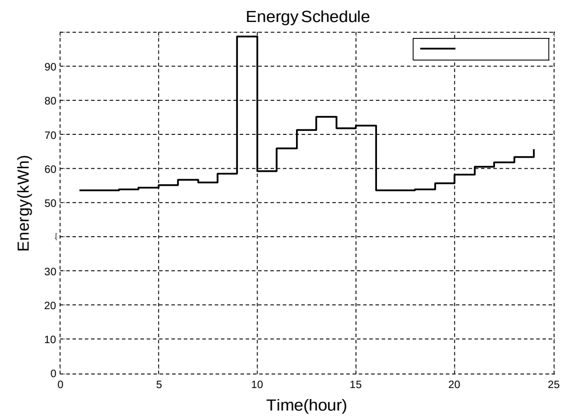


Figure 2: Energy scheduling by using grid only

When battery storage is available, we can use the above MPC-based co-scheduling algorithm to store electricity in battery during off-peak hours, and deliver electricity to the HVAC system during on-peak hours to reduce the energy cost. Fig. 3 shows the result with a 500-Ah battery storage. In the figure, the black curve represents the electricity provided by the power grid to support HVAC system. The area between black and red curves is the electricity stored in battery during off-peak hours. The area between black and blue curves is the electricity delivered by battery to reduce the on-peak electricity consumption from the grid. The higher values along red and black curves are the electricity consumption from the power grid. Compared with Fig. 2, the grid electricity consumption is much more even over time with the usage of battery storage, thus reducing both electricity consumption charge and peak demand change.

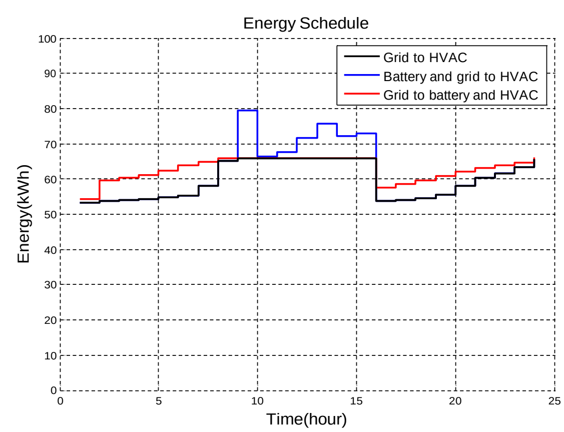


Figure 3: Energy scheduling by using power grid and battery storage

We also studied the impact of battery storage capacity on the potential energy cost saving. Fig. 4 shows the projected total energy cost reduction over a month with different battery capacities (varying from 50 Ah to 500 Ah). It is calculated by comparing the total cost by using battery and grid electricity versus the total cost by using only the grid electricity. Note that after the battery capacity exceed 500 Ah, the total cost reduction stops increasing. That is because the battery capacity is already large enough for the current HVAC system and the addition capacity is not being utilized.

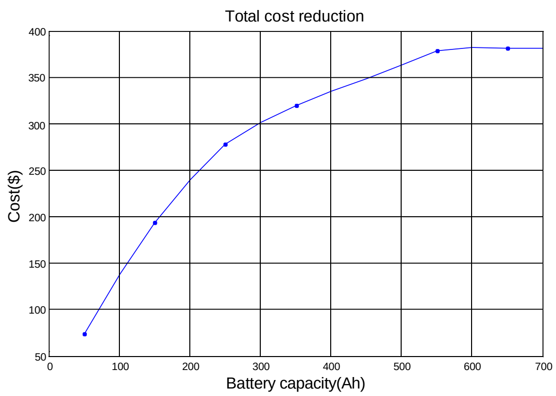


Figure 4: Total cost reduction with different battery capacities

3. BATTERY FOR EV CHARGING

We also conduct an initial study on the impact of using batter storage, together with solar PV, to reduce the energy cost for EV charging and other fixed building energy loads, as shown in this section.

Full electric vehicles (FEV) and hybrid electric vehicles (HEV) supporting plug-in charging from the grid are increasingly drawing attention from car manufacturers and customers in various aspects. HEV as well as FEV are known to have very low carbon emission and low cost per mile. PV installation in a building offers a number of benefits such as electricity bill reduction and carbon emission reduction. However, mismatch between the PV power generation and EV charging/residential load demand hinders its true benefits. An energy storage system (ESS) for a PV installation helps relieve the mismatch by storing the electrical energy during daytime and using it during the nighttime. Fig. 5 illustrates a generalized system architecture for grid-connected PV systems for EV charging. The load is powered by the PV array, power grid, or both.

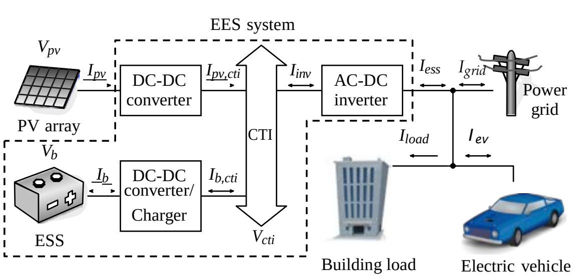
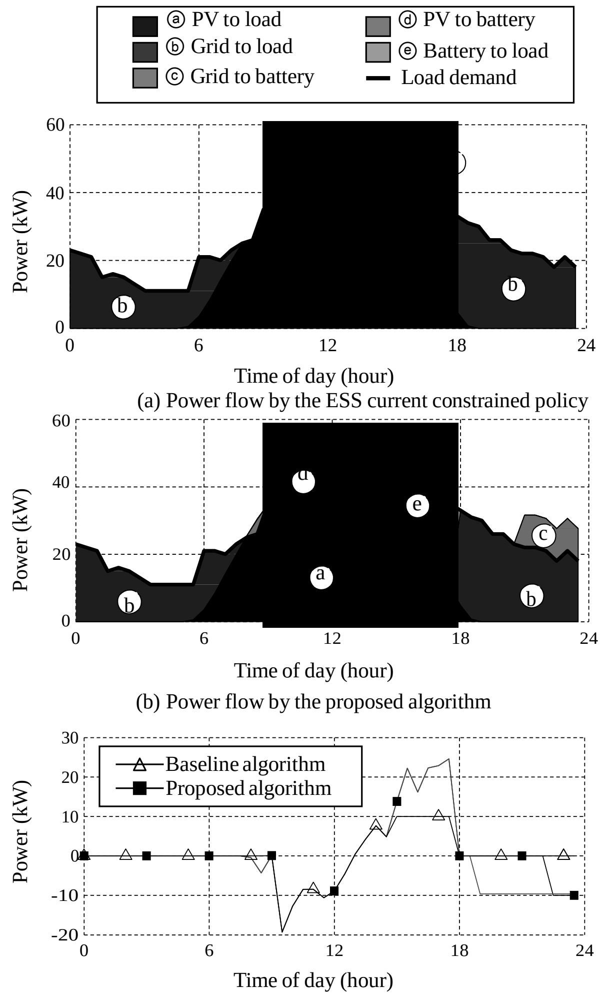


Figure 5: Electrical vehicle charging from grid-connected PV powered building.



(a) Power flow by the ESS current constrained policy

(b) Power flow by the proposed algorithm

(c) ESS power flow where negative value means charge

Figure 6: Power input and output variation with time for charging of Prius sized battery.

The low cost per mile of an EV largely depends on low-cost grid electricity aided by subsidies from the government. However, the financial inducement is likely to end when the EV market reaches the maturation phase, where the impact of the EV charging power on the grid would be significant [18]. EV charging power is significantly higher than the average residential load demand, which would form a large portion in the total electricity bill. Therefore, energy management considering the EV charging power and electricity bill minimization would be essential in the future.

Minimize electricity bill for a day, that is,

$$cost_{day} = \sum_{n=1}^{N} C[n]p_{Grid}[n], \tag{15}$$

where $C[n]$ is the unit price of the Grid electricity ($/kWh), $p_{Grid}[n]$ is the power drawn from the Grid (W) at time slot n, and N is the number of time slots per day (note that in this study, we did not consider the peak demand charge).

We perform a simulation for the setup shown in Fig. 5 for a day. The power demand characteristic of the building is comparable to that of the UCR CE-CERT building testbed, which exhibits peak load around 60 kWh. We utilize 1 MWh $LiFePO_4$ batteries to use cheap electricity during the night and residual PV energy. PV panel outputs about 50 kW under 1000 W/m^2, which is comparable to the peak load value during the day. The power flow for two different ESS management policies, (a) maximum current constrained, and (b) proposed method are shown respectively in Fig. 6. The basic operation of the policies is to store cheap grid electricity during the night and PV power to the ESS and to use it during the peak hours where the grid electricity is expensive and to support high power requirement of EV charging. The first policy constrains the ESS current to be lower than a threshold that it might not fully utilize the benefits. The proposed policy based on [17] considers efficiency loss in the converters and rate capacity loss in the ESS to find a better solution. The resultant electricity bill for a day is 39.55 $/day, and 34.71 $/day, respectively.

4. BATTERY MANAGEMENT SYSTEM

In this section, we present our design of a battery management system. The basic functionalities of a BMS can be classified as monitoring the status, controlling charge and discharge, and maintaining safety operation. As a pilot study, we focus on monitoring features for BMS. A BMS monitors the status of the batteries by utilizing with electrical and thermal measurements, such as voltage, current, and temperature of the battery. With the measurements, a BMS can compute and indicate state of charge (SOC), remaining capacity, and state of health (SOH) [8].

There are many definitions and algorithms to calculate SOC, which depends on battery type and a number of cells. The typical definition of SOC, however, is based on finding scaling factor by using the maximum discharge capacity at the low rate of discharge, which can be expressed in Equation (16). Here Q_{max} is the integrated charge when the current voltage is reached to its termination from full charge. Q_{passed} is the current integrated charge [8].

$$SOC(\%) = (Q_{max} - Q_{passed}) \times 100 / Q_{max} \qquad (16)$$

Many methods have been developed to achieve remaining capacity of battery for SOC estimation. One of the methods is to use voltage correlation of battery, which is very straightforward and the most traditional method. It uses a correlation between voltage and SOC of battery. Many applications are using this method due to its simplicity although it has some accuracy issue. Another method is based on battery impedance due to the fact that battery voltage drop can be corrected by the impedance dependency on the state of charge and temperature. To calculate more accurate voltage drop, Coulomb counting method is invented. Recently, an advanced gauging method, Impedance Track, has been developed. This method uses a combination of both voltage-based and current-based methods. In addition, a thermal modeling is applied to this method to compensate for temperature effects, which is one of the battery characteristics [8].

State of health information indicates time to replace with new battery to users. Knowing current capacity is not the only important information in BMS. The current health of battery is also a critical indication. Generally, SOC calculation is based on the capacity of battery, so unhealthy battery has less maximum capacity. Without SOH, we could not achieve accurate SOC information. A typical SOH method is to find the ratio of aged capacity (Q_{aged}) and new capacity (Q_{new}). Due to variable temperature and discharge rate of battery, this method is not very accurate. Normally, SOH = 70% or 500 cycles are considered, because less than 70% causes fast IR drop in the battery characteristics [8].

$$SOH(\%) = Q_{aged} / Q_{new} \times 100 \qquad (17)$$

4.1 Remote programmable networked BMS

Our system is a remote programmable networked BMS to continuously monitor the various status of battery or battery pack and execute the essential desirable computations, such as SOC and SOH. Those continuous measurements are logged in the BMS system and transmitted to a central server. Finally, the user or administrator can see the status and make appropriate feedback to battery. As pilot study, we use commercial off-the-shelf (COTS) IC for the measurement and computation for BMS. Our algorithm will be applied to the computational block in the future step. Fig. 7 shows our whole system diagram. Fig. 8 show our implementation for the programmable networked BMS. More details will be described below.

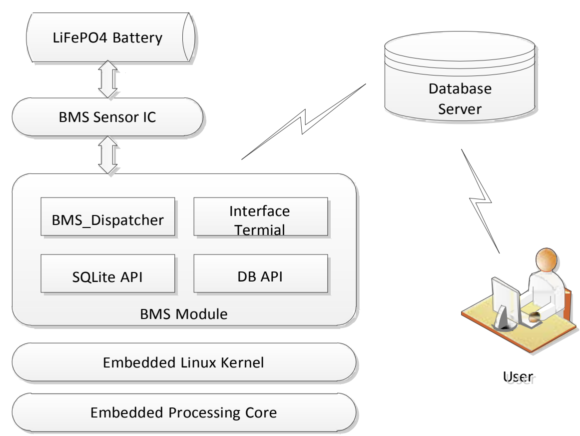


Figure 7: Battery management system (BMS) diagram

For a processing core of BMS implementation, we chose a low-cost and small form factor ARM V6 core platform, Broadcom BCM2835 system on a chip (SoC), which delivers an optimal balance of low risk, low cost, and low power for cost-sensitive applications. It provides 700MHz clock, 512Mbyte DDR2 memory, and Ethernet PHY [3].

The lithium iron phosphate (LiFePO4) battery is used for this prototype. The basic measurements of LiFePO4 battery is conducted by a COTS battery sensor IC (BQ34Z100 from Texas Instrument), which provides voltage, current, and temperature information to monitor and diagnosis a battery [1].

The open source Debian based embedded Linux Kernel 3.1 with I2C controller module is employed to drive COTS battery sensors to monitor battery. This Linux kernel and our software module based BMS can be reconfigurable in the

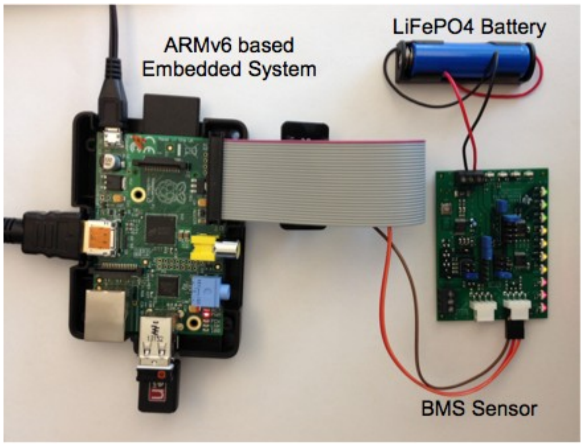


Figure 8: Battery management system (BMS) implementation

network [4]. We built the module called BMS dispatcher, which aggregates the data from the sensors and transmit it to local and remote storage.

We use SQLite for the local logging features. It is an open-source software library that implements a self-contained, server-less and transactional SQL database engine [5, 2]. For a central server side, we use MySQL database server for gathering the distributed BMS to monitor and actuate the whole BMS systems.

5. CONCLUSIONS

In this work, we address the application and management of battery storage for building energy efficiency. At the system level, we present an MPC-based algorithm to co-schedule HVAC control and battery usage to reduce energy cost, and we also conduct another study on using battery storage for EV charging and other fixed building energy loads. At the circuit level, we present a battery management system design to monitor, control and protect the battery storage system and maximize its performance and efficiency. We are currently working on integrating these elements into a holistic framework, and implement and evaluate them on our building testbed through field tests.

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Novel solar cogeneration trough system based on stretched microstructured Mylar film.

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ABSTRACT

Hybrid CSP / CPV (Concentrating Solar Power / Concentration Photovoltaic) systems provide a good alternative to traditional CPV systems or CSP trough architectures. Such systems are often described as solar cogeneration systems.

Trough systems use mainly the IR portion of the spectrum in order to heat up a pipe in which water is circulating. CPV systems use only the visible portion of the spectrum to produce the photo-voltaic conversion. Due to the achromatic nature of traditional thermal trough CSP systems, it is very unlikely that a CPV system can be integrated with a CSP system, even a low concentration CPV system (LCPV).

We propose a novel technique to implement a low concentration CSP/LCPV system which relies on commercially available solar trough concentrators / trackers that use reflective stretched Mylar membranes. However, here the Mylar is embossed with microstructures that act only on the visible portion of the spectrum, leaving the infrared part of the solar spectrum unperturbed.

This architecture has many advantages, such as: the existing Mylar-based thermal trough architecture is left unperturbed for optimal thermal conversion, with linear strips of PV cells located a few inches away from the central water pipe; the infrared radiation is focused on the central pipe, away from the PV cells, which remain relatively cool compared to conventional LCPV designs (only visible light (the PV convertible part of the solar spectrum) is diffracted onto the PV cell strips); and the Mylar sheets can be embossed by conventional roll-to-roll processes, with a one-dimensional symmetric micro-structured pattern.

We show how the positive master elements are designed and fabricated over a small area (using traditional IC wafer fabrication techniques), and how the Mylar sheets are embossed by a recombined negative nickel shim. We also show that such a system can efficiently filter the visible spectrum and divert it onto the linear strips of PV cells, while leaving the infrared part of the spectrum un-perturbed, heating up the water pipe.

1) INTRODUCTION

The growing number of Photovoltaic Systems (PV) installed recently shows the surge of popularity of such systems. It is interesting to note that the cost per Watt has decreased dramatically from $20 per Watt in the early 1980s to nearly $1 per Watt ("parity") today. There are two ways to reduce this cost: either reduce the cost of the conversion material (Silicon) or reduce the total area of the conversion material by using concentration architectures. Concentrating technologies are seen in two forms: CST (Concentrating Solar Thermal), more commonly referred to as CSP (Concentrating Solar Power), and CPV (Concentrating Photovoltaics).

Both CSP and CPV systems require some kind of solar tracking gear including a motor and an encoder. Also, both systems will work best in regions with direct illumination (diffused illumination will reduce the efficiency of such concentrating systems) where the Annual Solar Radiation exceeds 2000 kW/h/m^2.

Fig. 1 shows the projected solar markets for 2020 from the Concentrating Solar Power Report 2008 by the Prometheus Institute & Green Tech Media.

SPIE Eco-Photonics 2011: Sustainable Design, Manufacturing, and Engineering Workforce Education for a Green Future, edited by Pierre Ambs, Dan Curticapean, Claus Emmelmann, Wolfgang Knapp, Zbigniew T. Kuznicki, Patrick P. Meyrueis, Proc. of SPIE Vol. 8065, 80650G · © 2011 SPIE · CCC code: 0277-786X/11/$18 · doi: 10.1117/12.896197

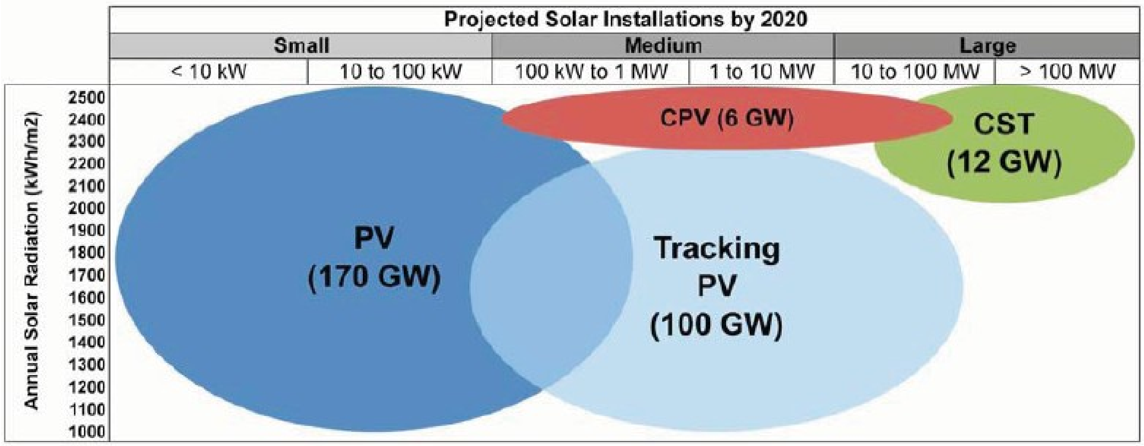


Figure 1: Projected Solar Markets for 2020
(Concentrating Solar Power Report 2008 Prometheus Institute & Green Tech Media).

This report shows that tracking based systems (including Tracking PV, CPV and CST) will provide more than 40% of the global needs (118GW for a global need of 288GW). Fig. 2 shows that after 2030, the amount of hybrid solar power generation will increase dramatically.

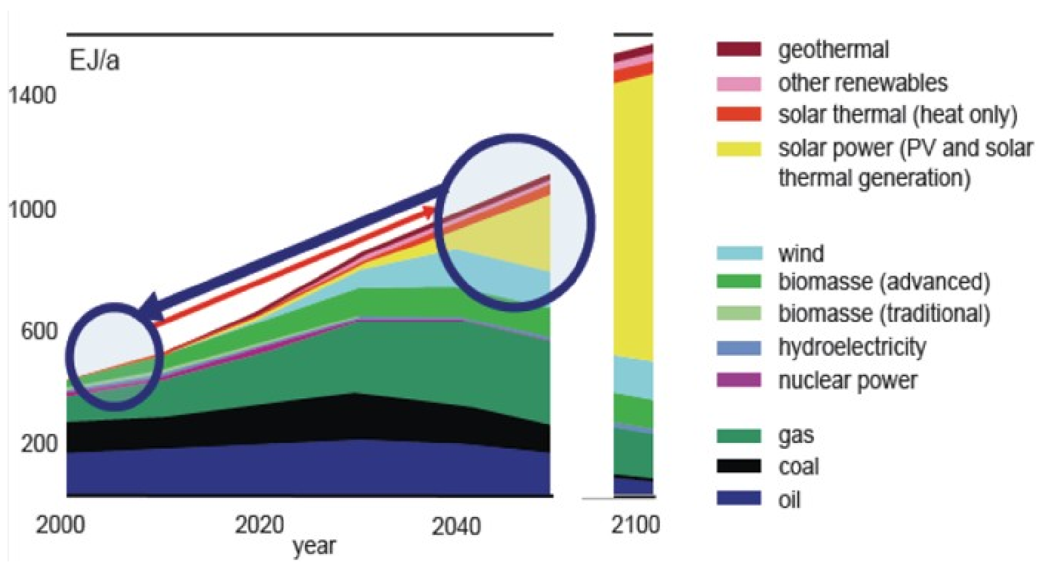


Figure 2. Solar Roadmap projection for hybrid solar power (thermal + PV) generation
(source: German Advisory Council on Global Change, 2003 – www.wbgu.de)

The case is therefore made for its use in the same areas of the globe as hybrid CSP/CPV systems. Such hybrid systems are difficult to implement in a single architecture, however.

2) EXISTING HYBRID CSP/CPV ARCHITECTURES

Most of the CSP systems today are implemented as reflective solar trough systems using synthetic oil. High concentration CPV (HCPV) systems have found their way into industry by the use of high efficiency III-V solar cells that were initially developed for space applications. HCPV systems are usually implemented as

reflective systems with dual stage convex mirrors (Sol-Focus Inc.), or transmissive systems with dual stage Fresnel concentrators using homogenizer rods (Concentrix Inc. or Amonix Inc.).
CSP and CPV systems are very different in their architecture and in their concentration power (around 5x to 10x for standard CSP, 100x to 500x for standard CPV, and up to 2000x for HCPV). They are also different in the way they track the sun (1X tracking systems in solar troughs with 0.5 degrees pointing accuracy and 2X tracking in HCPVs with 0.1 degree pointing resolution). These intrinsic differences make it difficult to develop a system which could produce both thermal and photovoltaic conversion, not to mention the other obvious problems of partitioning both conversion functionalities and spatially multiplexing both conversion cores (oil pipe and PV cells). Thus, CSP and CPV systems are normally used side by side as two heterogeneous and distinct systems. Some attempts have been made to use solar trough CSP architectures to implement low concentrating PV (LCPV) systems only, such as the one developed by Skyline Solar Inc. (see Fig. 3).

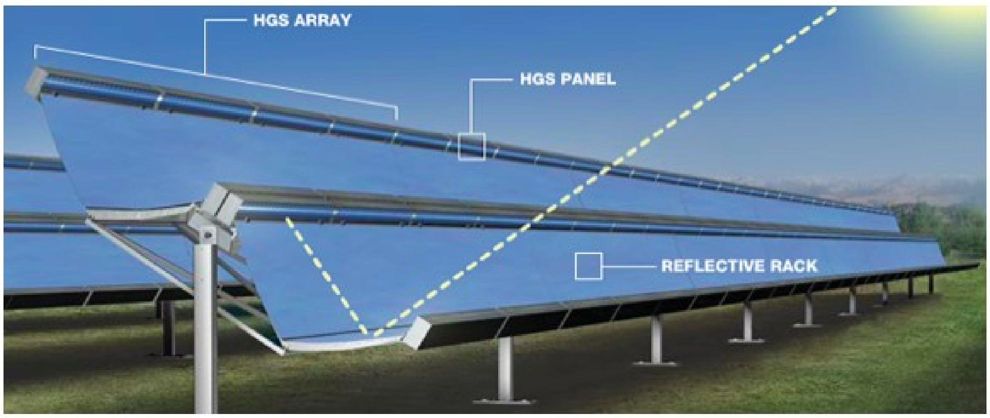


Figure 3. Implementation of LCPV systems using CSP based trough architecture (Skyline Solar Inc.)

Another company (Cogenra Inc.) has implemented a true hybrid CSP/LCPV system also based on solar trough architecture (see Fig. 4). This system is an achromatic system and is therefore not best suited for hybrid CSP/PV operation, since thermal radiation still passes through the PV material before being carried away by the fluid in the pipes located behind the PV cells.

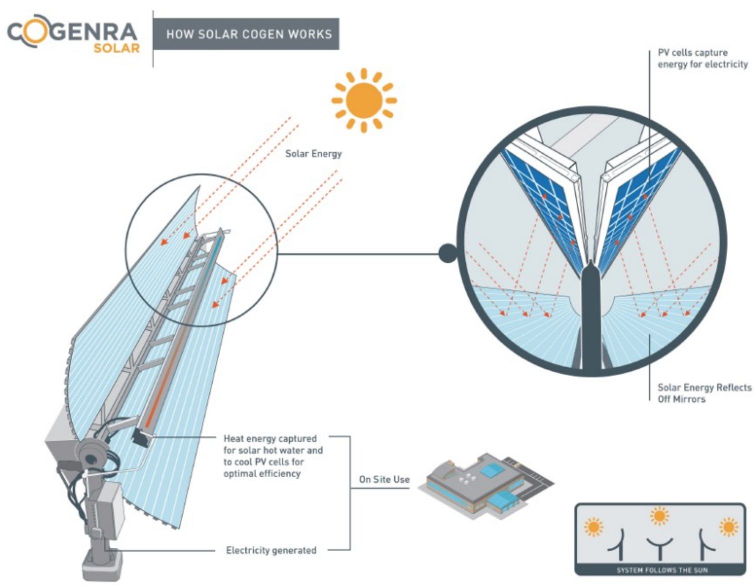


Figure 4. Hybrid achromatic CSP/LCPV system based on solar trough architecture (Cogenra Inc.)

3) PROBLEMS LINKED TO EXISTING COGENERATION SOLAR SYSTEMS

There are various problems arising from existing solar cogeneration systems and especially from trough based cogeneration systems:

a) The achromatic nature of the reflective trough produces an IR focus as well as a visible focus on the cells and the pipe, thus heating up the PVs and absorbing precious visible on the pipe.
b) When using trough based systems, the parabolic structure of the reflector is suitable for focusing light onto a cylindrical pipe, but not for producing uniform illumination on a planar PV cell.
c) The optical concentration ratio for optimal thermal conversion is very different from the concentration ratio for optimal silicon-based single crystal PV conversion.
d) The optics required to produce uniform illumination on a narrow PV strip from a reflective trough system are aspheric and complex, and therefore expensive (no cylindrical/parabolic shape as with basic CSP systems)
e) Due to high illumination angles, the PVs have usually to be tilted (see Cogenra Inc.) in order to produce acceptable absorption on the silicon and thus acceptable efficiency.

We will attempt to solve these drawbacks by introducing a novel trough-based hybrid CSP/LCPV architecture based on an existing CSP architecture where the reflector is composed of a stretched micro-structured Mylar sheet.

4) EARLY IMPLEMENTATIONS OF FOLDABLE REFLECTIVE OPTICS

Foldable and stretched optics have been studied and developed over many decades for numerous applications where mass and volume is critical, and where bulky and heavy refractive or reflective optics are therefore not a solution. Those applications are mainly space based applications (telescope mirrors, solar sails, etc.) [1].

For example, foldable Fresnel lenses have been developed to serve as primary mirrors in space-based telescopes, where the volume and mass of the rocket payload is very critical (*there is plenty of space in space, but not in the tight rocket payload*). Such optics can be either diffractive or refractive, operating in either transmission or reflection modes. Most of them have been reflective, due to the risks of chromatic aberrations in such broadband high resolution imaging systems.

Solar wind sails have also been developed based on foldable optics.

In another implementation of foldable optics, inflatable optics have been studied and developed for various applications, however not space-based in these cases. Inflatable CSP trough systems with one transparent side and one reflective have thus been proposed in the literature [2].

5) ARCHITECTURE OF OUR SOLAR COGENERATION SYSTEM

Our dual CSP/LCPV cogeneration solar system is based on an existing trough CSP system developed by Focal Point Energy of San Jose, CA. The system is comprised of a Mylar film stretched over a skeleton aluminum parabolic structure which holds it firmly in place. The trough tracks the sun in 1D with a pointing accuracy of 0.5 degree (a pointing accuracy of 0.1 degree is needed for larger concentrations of 500 suns to 2000 suns). The CSP concentration ratio obtained in our trough is approximately 20 suns. The main breakthrough of this architecture is the way the Mylar film is stretched over the aluminum structure and is held in place without any major deformation from wind, vibrations or temperature gradients. This architecture as well as the device used to stretch and hold the Mylar film in place has been patented and is shown in Fig. 5.

Based on this architecture, we propose making two minor architectural changes which will allow the optimal second optical functionality (LCPV) to be implemented in addition to the original CSP:

- First, we produce sets of microstructures on the Mylar sheets by roll-to-roll embossing, which results in a diffractive effect in addition to the existing cylindrical/parabolic reflective effect of the trough.

- Second, we insert two strips of linear monocrystalline silicon PV cells, each optimized for 5-7 suns concentration, on the underside of the cover glass protecting the trough. Compare this with the CSP effect, which uses the full extent of the trough's 20x sun concentration capability.

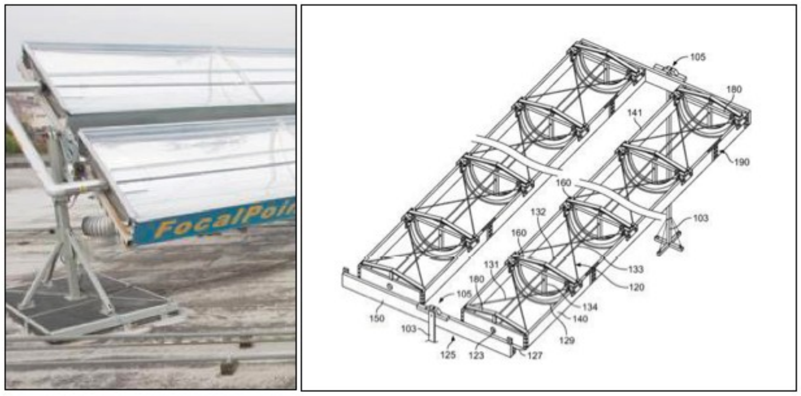


Figure 5. Base architecture used for our dual CSP/LPCV solar conversion system
(Mylar stretched trough system from Focal Point Energy of San Jose, CA. and patent # US 210030887)

The microstructures produce an added non-imaging optical functionality on top of the trough's focusing functionality. The diffractive microstructures are not present everywhere on the reflector, but are symmetric about the center. The added functionality acts only on the visible part of the spectrum and shifts the optical axis of the trough, producing as well a beam-shaping and homogenizing effect on the visible part of the spectrum. Fig. 6 shows the hybrid optical functionality.

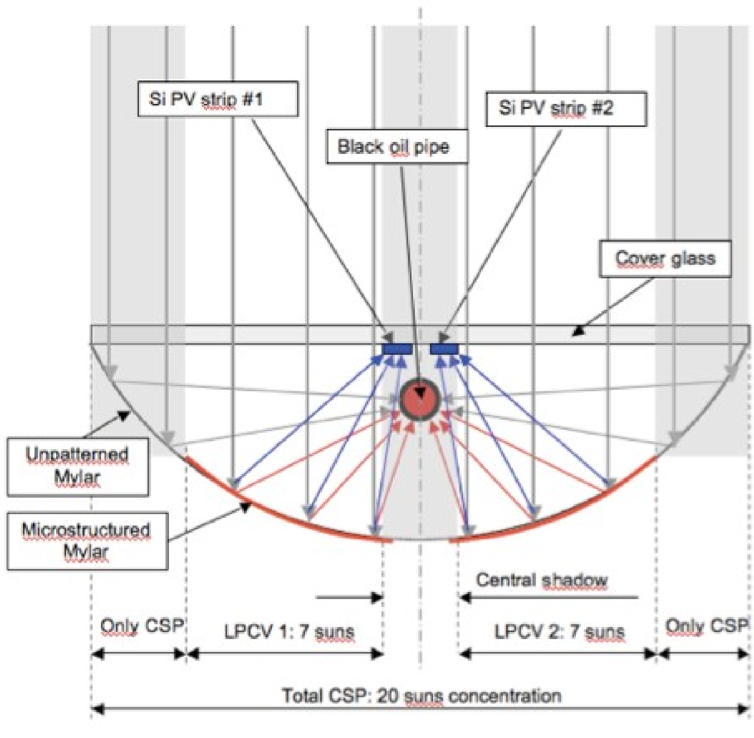


Figure 6. Hybrid optical functionality of the dual CSP/LCPV solar conversion system

The center part of the system produces a shadow region formed by the pipe and the two PV strips. This results in the decrease of the focus region in the same manner as a super-resolution lens would act with a central obscuration disk. In order to collect the light lost here, dual sided PV cells can be used, but the amount of light gained might not outweigh the price increase when going from single sided PV cells to dual sided PV cells.

Fig. 7 shows the two numerical apertures of both photo conversion systems implemented by the same hybrid reflective/diffractive Mylar sheet for visible and IR illumination.

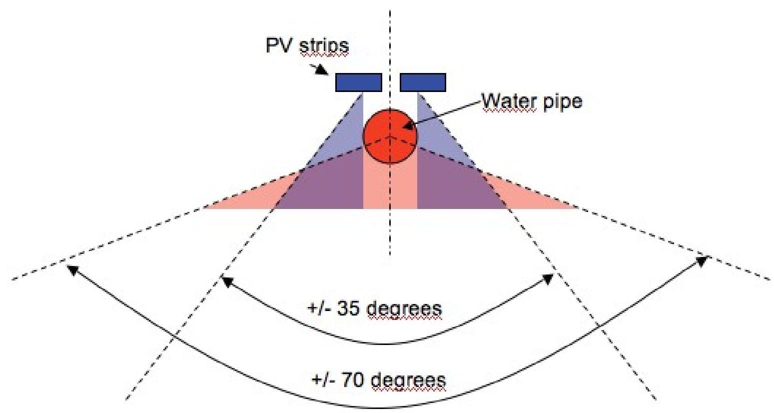


Figure 7. Numerical apertures for CSP and LCPV from the same hybrid reflective/diffractive Mylar sheet.

Note that such a hybrid lens design has already been used in industry for more than a decade in optical data storage: in that application, it is used in a transmission configuration to produce a dual focus from a single lens. Hybrid refractive/diffractive OPU (Optical Pick-up Unit) objective lenses are used in CD/DVD drives. Under 780nm laser illumination (near IR) an optimum numerical aperture and spherical aberration correction is produced (focused spot) to read CD tracks through a 1.2mm overcoat, and for 650nm (visible – red) a different numerical aperture and spherical aberration correction is produced to read DVD tracks through a 600-micron overcoat. The diffractive part of the lens does not cover the entire refractive objective lens to produce the different numerical apertures.

6) MAIN ADVANTAGES OF OUR COGENERATION SYSTEM

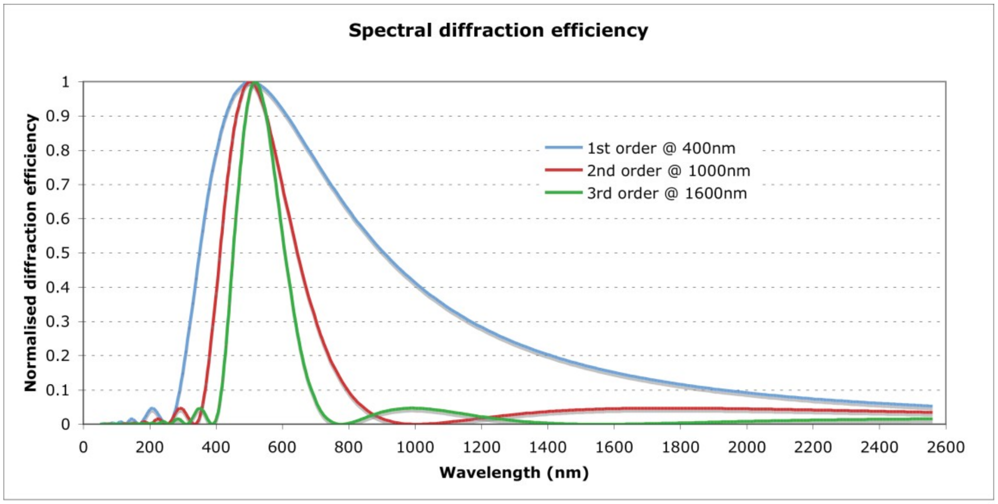
Our system has major advantages over simple LCPV or hybrid CSP/PV systems, such as:

- Both optical functionalities (focusing on a pipe and focusing on PV strips) have been optimized independently, but based on the same basic trough architecture (with different focus locations, different concentration ratios and different numerical apertures). We have therefore been able to produce optimal illumination conditions for both systems at the same time with a single trough architecture.
- The patterned Mylar section produces the exact concentration ratio optimal for Silicon PV cells (around 5 to 7 suns), whereas the entire Mylar produces concentration optimal for pipe heating (around 20 suns).
- Heating of the PV strips is considerably reduced by the de facto heat sink represented by the central pipe.
- The cost of integrating this dual functionality is minimal, and does not alter the original structure of the CSP trough system in any way. The only changes are microstructuring part of the Mylar and inserting two strips of Si PVs under the cover glass.

7) DESIGN OF THE DIFFRACTIVE MICROSTRUCTURES

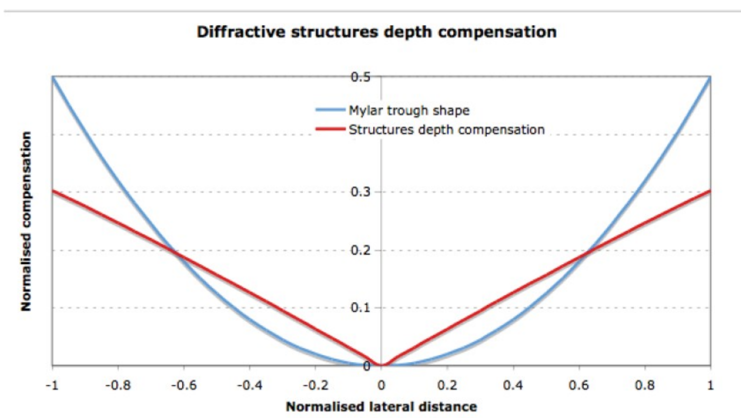
The spectral focusing selectivity on CSP and CPV is not based on the chromatic dispersion of diffractives, but on the spectral diffraction efficiency of reflective diffractives.

Graph 1 shows the diffraction efficiency of a typical blazed 1D cylindrical lens over a large spectrum ranging from 300nm (UV) to 3 microns (IR). We have plotted three possible implementations of the blazed diffractive, as a first order element etched for 400nm central wavelength, a second order element etched for 1 micron wavelength, and a third order element etched for 1.6 micron wavelength. In all three cases, the efficiency is maximal over the visible spectrum and minimal over the IR part of the spectrum. By increasing the diffraction order, one can narrow the filter functionality and get a higher extinction ratio between visible and IR radiation.



Graph 1. Spectral diffraction efficiency modulation of microstructure on the reflective Mylar.

When going to higher orders at higher wavelengths (increasing the extinction ratio), however, the structures must be etched deeper into the reflective surface. Fortunately we are operating in reflection mode, having only one quarter of the depth required if the element would be used in plastic or glass transmission. Triggering higher orders for elements etched for higher wavelengths is therefore a lesser challenge and possible. In our first demonstrator, we are considering a first order etched for a blue color around 400nm.
In addition, as the illumination angle on the Mylar varies from the edges to the center of the trough, the microstructures must also be modulated in order to produce the same efficiency over the entire extent of the Mylar. The compensation is performed by varying the depth of the structures, as depicted in Graph 2.



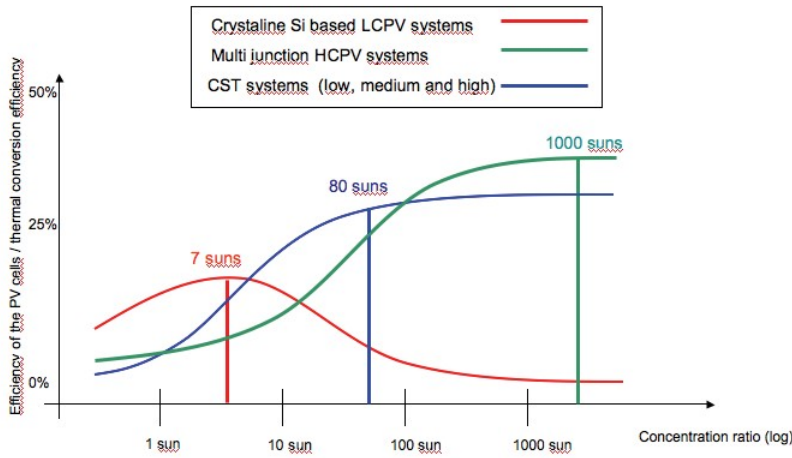
Graph 2. Modulation of the depth of the diffractive structures to compensate for illumination angle change along the Mylar trough.

We have also chosen to reduce the diffractive effects to the smallest possible angles in order to:

- produce the largest possible structures on the Mylar; and
- produce the smallest chromatic dispersion over the diffracted part of the spectrum.

We reduce the maximum deflection angle created by the diffractive element by structuring the Mylar only from the point where the illumination-to-Mylar angle reaches 40 degrees, and the deflection produced by the diffractive at that point.

We have already described the effect of reducing the concentration ratio to 7 suns, the level adequate for Si cells (compared to the 20 suns of the trough), by using two PV strips placed at each side of the central thermal pipe and by structuring only part of the Mylar (i.e. the central part). Graph 3 shows the various optimal concentration ratios of CST and LCPV (also HCPV).



Graph 3. Optimal concentration ratios for CST, LCPV and HCPV systems.

If we were to use multi-junction cells in our cogeneration system (optimized for specific wavelength conversions but far more expensive to produce), we would not only increase the concentration ratio without reducing the efficiency, but could use the otherwise parasitic spectral dispersion created by the diffractive structures over the visible spectrum in order to produce optimal spectral illumination of the two strips from the center to the edges (continuous spectral change from blue on the inside to red on the outside).

8) NUMERICAL SIMULATIONS

We have used semi-scalar physical optics to simulate the cogeneration system. This is valid, as the microstructures sizes exceed 10 times the wavelengths of the diffracted waves (visible). On the IR part of the spectrum, this would not be valid (since the microstructures can be much smaller than the wavelength), but the depth of the structures result in such low efficiency (nearly zero) that the realm of validity of scalar theory is irrelevant (no diffraction). Therefore, scalar theory is used on the IR part only to reflect the waves, not diffract them. Fig. 8 shows numerical reconstructions at the foal region (pipe and side PVs) for various wavelengths.

One can notice that for green, only the PVs are illuminated, since the microstructures produce high efficiency (also see Graph 1). Some light with wavelengths near the quantum conversion limit of 1.1eV (1.13 microns) is not diffracted and therefore falls onto the central pipe. For longer wavelengths, all the light is focused on the pipe, with none falling on the PVs.

It is also noteworthy that the parasitic spectral dispersion effect produces an extra offset of the PV illumination lines when the wavelength increases. Fortunately, the diffraction efficiency decreases with wavelength, and the position of the light patch can be centered on the PVs for a central wavelength - green or red, for example.

Fig. 9 shows similar numerical reconstructions for a single wavelength (at the quantum efficiency limit of 1.13 microns) at various distances from the focus.

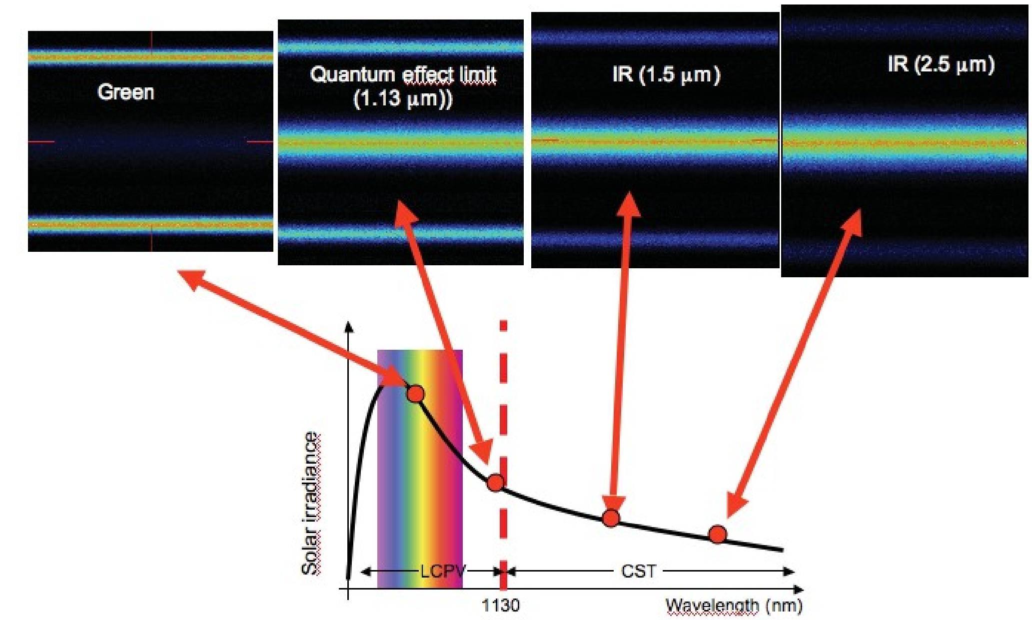
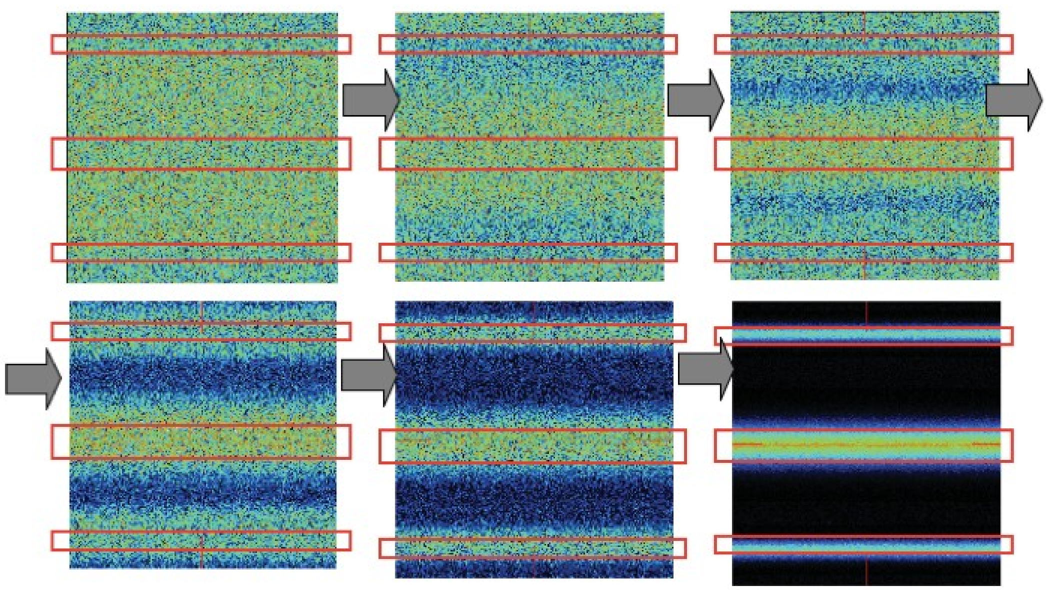


Figure. 8. Numerical reconstructions at various wavelengths at focus.



Figures. 9. Numerical reconstructions at various positions before focus for NIR light @ 1.13 microns.

9) TECHNOLOGICAL IMPLEMENTATIONS

In order to emboss the Mylar sheet with microstructures in the range of 5 to 10 microns at a depth of around 2 microns, we use standard microlithography technologies as described in [5]. The master is fabricated via direct laser write over 128 levels into a 1 micron thick resist. This quasi analog resist profile is then transferred into the underlying substrate by dry proportional RIE etch with an etching ratio of 2x. A nickel shim is then formed on the etched positive master. This negative master is then recombined with 6 other shims to produce a single lateral shim for the trough (only part of the Mylar is embossed, the central part). The shim is then multiplied (the structures are invariant in the longitudinal direction) and spun onto a drum for roll-to-roll embossing of Mylar by the mile (see Fig. 10).

We need an analog surface relief profile rather than a binary or multilevel profile in order to get strong diffraction efficiency over the visible spectrum in the second diffraction order as depicted in Graph 2.

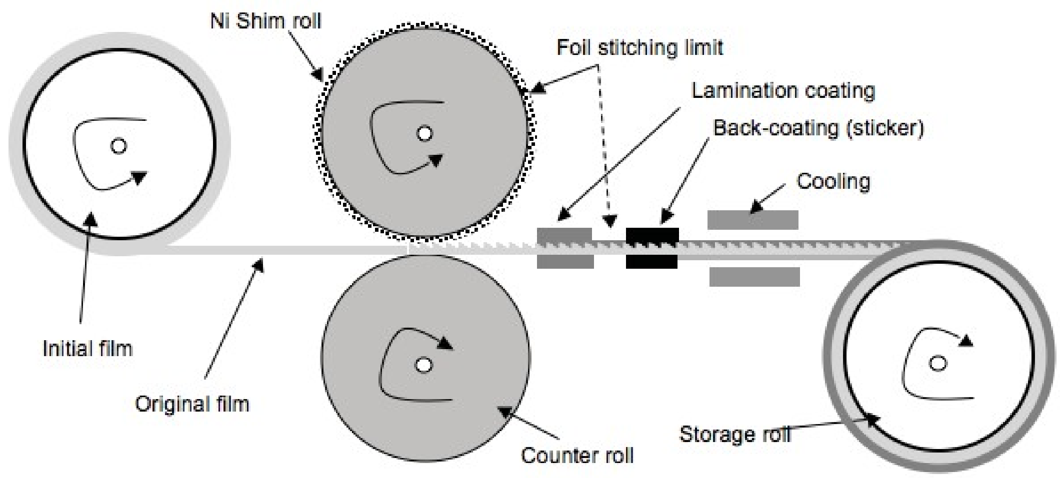


Figure. 10. Roll to roll embossing of Mylar sheet with microstructures.

10) CONCLUSION

We have demonstrated a novel technique to produce an efficient cogeneration CPV/T solar system which independently optimizes both concentration ratios, both focus locations, both illumination geometries and both numerical acceptance angles on a single and unique trough architecture.

In order to implement such a complex functionality, we use a hybrid reflective/diffractive trough reflector formed by a stretched embossed Mylar sheet. The modulation of the diffraction efficiency and the modulation of the embossed area provide the required degrees of freedom to design and fabricate such a cogeneration system.

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Solar microgrids to accommodate renewable intermittency

C. H. Wells, OSIsoft

***Abstract*—This paper describes a system to operate solar microgrids with V2G and carport solar panels within a municipal distribution system. A typical light industrial area has thousands of vehicle parking spaces at hundreds of large commercial and industrial firms. For a small municipal Utility with a city containing 400 commercial and industrial facilities, the total solar capacity would exceed 500 MW. Each microgrid also would include battery storage, micro power sources, and digital transformers for maximum efficiency and control. The system minimizes electric vehicle carbon footprint, integrates internal and external intermittent renewable resources, reduces distribution losses and costs, and increases service reliability.**

Hierarchical distributed controls use dynamic forward price signals to control the multiple Microgrids inside the municipal distribution system. These signals are computed at five minute intervals. The prices depend on distribution grid loads, solar generation, power losses and wholesale prices. Distribution losses and constraints are modeled using an Integrated System Model of the municipal network. This three phase model and the dynamic forward price signals are computed in real time on 128 "cloud based" servers.

Each microgrid uses two PMUs (Phasor Measurement Units) to measure power quality on both sides of the point of common connection. These PMU smart meters provide real time information for control, bi-directional energy accounting, real time state estimation and real time data feeds to NASPInet. The OSIsoft PI system is used for data acquisition and historization to meet data and benefit analyses requirements.

The proven CERTS microgrid design is implemented with local control of voltage and frequency. The CERTS microgrid controls are fast and smart, responding in milliseconds to changes in internal loads. The microgrid controller optimizes the operation of each component of the microgrid and its interaction with the dynamic forward price signals.

***Index Terms*—microgrid, solar, distributed energy resource, hierarchical control, forward pricing controls, vehicle to grid, V2G, PMU, phasor controls, CERTS controls, PHEV**

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I. Introduction

A highly flexible distribution system will be required to accommodate up to thirty-three percent renewable power into the grid. Additionally, it is doubtful that new transmission lines can be built to transport power from large Utility grade wind and solar energy generation facilities. For example, two "green" transmission lines have been rejected in California this year due to voter objections to having new transmission lines in "their backyard."

A highly flexible rooftop and carport panels are combined with batteries and micro-generation sources to form smart solar microgrids is proposed to meet the renewable portfolio standards of 2020. The proposed system will use the CERTS inverter technology[1] for the interconnection of components within each microgrid.

The microgrids will be controlled using a fixed forward price signal that is computed using a three-phase model of the grid. This includes all lines and components in the three-phase network. The model is used as the constraints in the optimal load flow solution to determining the real time price of power at each microgrid. The ISM[2] model from EDD[3] is used for this purpose. The ISM is used to solve the optimal load flow (OLF) solution in real time. This requires the use of one-hundred twenty-eight loosely connected distributed servers.

II. Microgrid Structure

Industrial/commercial facilities as well as large residential complexes will install rooftop and electric vehicle carport solar PV systems as well as batteries and micro-generators forming independent microgrids. Each microgrid includes solar Vehicle to Grid (V2G) controls. An independent weather station that will include solar radiation intensity as well as traditional temperature dew point and wind speed and direction will also be included in the system.

The microgrids may individually provide local frequency (autonomously) and voltage regulation. The system will include natural gas fired micro-source as well as battery storage for the transitions during the disconnected operation

[1] Consortium for Electric Reliability Technology Solutions

[2] Integrated System Model supplied by from Electric Distribution and Design, Blacksburg, VA.

[3] Electrical Distribution Design, Blacksburg, VA.

and for smoothing and peak shifting loads. The system will incorporate advanced power conversion equipment.

One of the major loads will be from an increasing number of electric vehicles. Other loads in the complex include desktop computers, heating, cooling, datacenter computers and lighting. Some of these loads are considered critical others can be shed as shown in Fig. 1. Employee electric vehicles would normally be in the “recharging” mode during

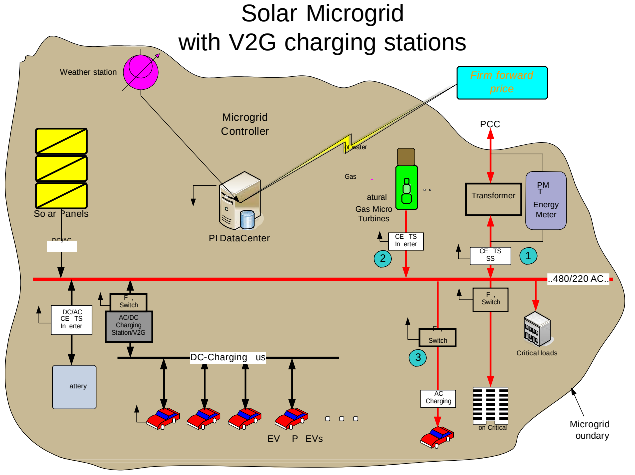

Fig. 1 A solar microgrid with natural gas fired backup generators as the non-renewable distributed energy source.

the early morning hours thereby getting the lowest rate for energy and causing the least stress on the Grid. While parked during working hours, employee vehicles would be charging immediately after arriving at the facility, but the battery sources would available to supply power back to the grid as might be necessary during periods of high load which normally would be four to five hours after arrival. The microgrid controller will store the detailed history of the microgrid and the energy consumed by each vehicle, power generation and detailed costs. The controller would be connected to each of the charging stations maintaining an accurate record of the energy consumption by each PHEV connected to that charging station.

The Micro-controller reads data from both critical and non-critical loads using its standard DataCenter software and also reads data from the weather stations as well as accessing data from the Internet as well as the firm forward pricing from the Hierarchical Microgrid Controller (HMC). At any time the local microgrid controller can make internal decisions to maximize its own internal objective function based on firm forward pricing or direct requests from the HMC. The critical loads are supported by the micro-sources (micro turbines or natural gas internal combustion engines). One scenario is for the microgrid to disconnect during periods of grid disturbance. In this case, the perimeter lighting loads could be shed keeping the desktop and datacenters and other critical loads running on the micro-sources and solar power.

Each microgrid is designed to provide limited local frequency and voltage regulation at the point of common connection (PCC) and the intention is to sell this regulation capability to the local wholesale power company. The frequency regulation method will be similar to that demonstrated by the US DOE on over 500 residential homes in the Pacific Northwest[4]. The local voltage support may be accomplished by adjusting the VAR compensation on the micro-sources. Regulation energy will be supplied when firm prices are sufficiently high so the microgrid can make significant profit from the sale of energy. Since the load closely follows solar generation, the solar panels can contribute to regulation during hot sunny summer days.

During emergency periods or periods of high loads during hot summer afternoons and or during large variations in wind power, the Grid may need access to power both for stability and for real or reactive power. Some of this can come from stored energy from the parked EV batteries (V2G). Each vehicle may have storage capacity of about 50 kWh (current estimate), or over 15 MWh of energy that could be made available to the Grid from 300 parked vehicles. This energy can be delivered at very high rates, for example easily 150 MW for six minutes or up to 5 MW for three hours. The dispatching of this power could be by Silicon Valley Power or by PG&E subject to constraints estimated from the real time network model. The communications would be from the controlling agency to the HMC that would in turn send signals to its microgrids to respond. One of the commands from the HMC could be to disconnect. In an emergency situation, the microgrid battery combined with available V2G power can provide the power necessary to maintain critical loads as the backup generators come on-line while charging the fleet. This can be viewed as a means of providing Uninterruptable Power (UPS) to critical loads near the parking facility.

The V2G can also be used to regulate local frequency. Power is delivered to the grid from the energy sources inside the microgrid when the local frequency is low and similarly the batteries charge when frequency is high. The microgrid controller will control vehicle charging at the lowest cost of power while providing “regulation” services to the Grid. The lowest cost is to use renewable solar energy for this purpose. A microgrid typically has multiple sources of local power, most often backup generation, solar, or wind (Distributed Energy Resource, DER). Natural gas energy cost is about 1/3 that of electricity and if the waste heat is recovered the overall efficiency is increased to more that 70 percent.

The microgrid will include a 1-2 MWh lead-acid battery. This will be used as the emergency energy source for maintaining load while the DERs are starting after the Grid loses power or when the Grid curtails the microgrid. The battery will be charged during early morning hours and used to help maintain regulation during the day when the EV fleet is not connected to the Grid. This power would also be managed by the microgrid controller.

A PMU will be installed across the transformer-switch. This unit makes synchronized measurements of power quality including frequency, phase angle, power factor, real and reactive power, flicker, and the first 50 harmonics. These are important since the characteristics of the power electronics and the chargers in the PHEVs can possibly produce high levels of total harmonic distortion of the AC wave forms. The AC bus will feed critical loads like the data centers that may be located inside the building. Having the battery and the micro-turbines provides full UPS protection for the critical industrial loads.

The AC power can also be used to charge the PHEVs. Some of the fleet may not have been converted to DC charging connections and will use their local built in rectifiers for charging directly from AC. The AC charging system will be the IEEE standard 220 volt single phase fast charging system. A larger back-to back rectifier-inverter will also be installed and connected direct to the DC bus. This rectifier could be a solid-state device. The solar DC power will be run through a DC /DC converter to maintain the correct DC voltage for charging the PHEVs. The goal is to by-pass the built-in rectifier in the PHEV to improve the overall efficiency of the charging system. So the DC bus voltage will be regulated so that its voltage is sufficient to rapidly charge the PHEVs.

The DC bus will have the storage batteries which will include spare Li-ion batteries for fast discharge for regulation as well as slower discharge batteries with more energy storage (2 MWh is the planned capacity). These carport panels also collect rain-water and water could be used to cool the PV panels.

The microgrid could also have small micro-sources. These would be small natural gas fired internal combustion generation providing backup power if the main AC feed should fail or if there are many consecutive cloudy days without sufficient power to charge the vehicles. For this reason the system is designed to handle the case where the PV panels do not provide sufficient power, the storage batteries do not provide sufficient power and the main connection to the AC grid is not available. In this case the micro-turbines provide sufficient power to charge the vehicles at the standard rates and provide UPS power to the buildings. The system will be controlled via a microgrid.

A brief description of the microgrid controller is outlined below. This follows the basic system design of Lasseter[5] and demonstration by CERTs. This was funded by the California PUC and the demonstration was hosted by AEP in Columbus, OH.

The key to good control is the use of the smart inverters. These provide the control and flexibility required for plug-and-play functionally. The microgrid controller insures that; new micro-sources can be added to the system without modification of existing equipment. The microgrid can connect to or isolate itself from the grid in a rapid and seamless fashion following the IEEE 1547 standards for DERs. Reactive and active power can be independently controlled while meeting the dynamic needs of the loads.

The controller techniques described below rely on the inverter interfaces found in the micro-sources and storage technologies. A key element of the control design is that communication among micro-sources is unnecessary for basic microgrid operation. Each micro-source controller responds to system changes without requiring data from the loads or other sources. The microgrid assumes that the power electronic controls of current micro-sources are modified to provide a set of key functions demonstrated by the California Public Utility Commission. These control functions include the ability to; regulate power flow on feeders; regulate the voltage at the interface of each micro-source; ensure that each micro-source rapidly pickups up its share of the load when the system islands. In addition to these control functions the ability of the system to island smoothly and automatically reconnect to the bulk power system is another important operational function. The critical system performance components are the voltage versus reactive power droop and power versus frequency droop. Voltage regulation is necessary for local reliability and stability. Voltage control must also insure that there are no large circulating reactive currents between sources. With small errors in voltage set points, the circulating current can exceed the ratings of the micro-sources. This situation requires a voltage vs. reactive power droop controller so that, as the reactive power generated by the micro-source becomes more capacitive, the local voltage set point is reduced. Conversely, as reactive power becomes more inductive, the voltage set point is increased.

Frequency droop control by microgrids can provide premium power services to the grid. The microgrid can island smoothly and automatically reconnect to the bulk power system, much like a UPS system while maintaining NERC frequency specifications. In island mode, slight errors in frequency at each inverter and the need to change power-operating points to match load changes are controlled by the microgrid controller.

When the microgrid is connected to the grid, microgrid loads receive power both from the grid and from local micro-sources. If the grid power is lost because of voltage drops, faults, blackouts, etc., the microgrid transfers smoothly to island operation to prevent anti-islanding functionality. When the microgrid separates from the grid, the voltage phase angles at each micro-source in the microgrid change, resulting in an apparent reduction in local frequency. This frequency reduction coupled with a power increase allows for each micro-source to provide its proportional share of power.

The equipment protection strategy is different when the microgrid is operating disconnected from the grid. So additional logic is provided in the microgrid controller.

A. 3-D Model of the microgrid

Each microgrid will have parking spaces with different orientations and each of the buildings within the microgrid will have unique locations and limitations of where solar panels can be located. Construction drawings for the carports and for the additional remotely controlled switches will be generated from the 3D model. The name and location of each meter in the microgrid will also be included in the model and drawings will be created automatically from the model.

[5] http://certs.lbl.gov/certs-der-micro.html

A typical microgrid overhead view is shown below in Fig 2. This is a typical industrial complex in the City of Santa Clara.

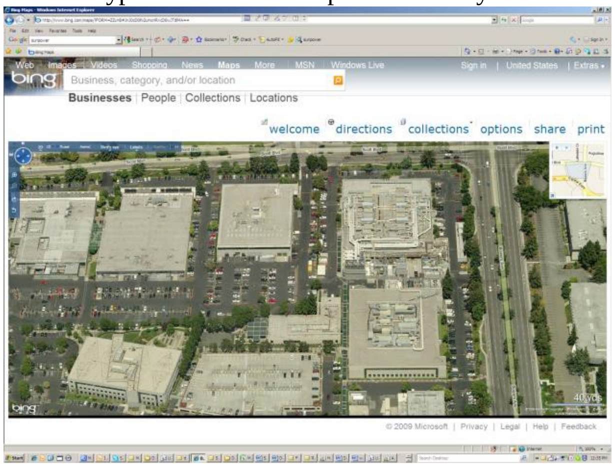

Fig 2. An aerial view a typical industrial complex in Silicon Valley (City of Santa Clara, CA.)

The model includes all carports and the internal wiring to each breaker box in the facility. Existing facility drawings would be used the start the modeling process, but each model will be field verified before construction drawings are created. From these drawings, firm fixed price quotations for the construction and installation of the equipment will obtained. The actual construction progress will be monitored using the 3D model. It may also be used for real time viewing on Internet browsers by authorized personnel within the complex. It is also likely that the model will be animated with

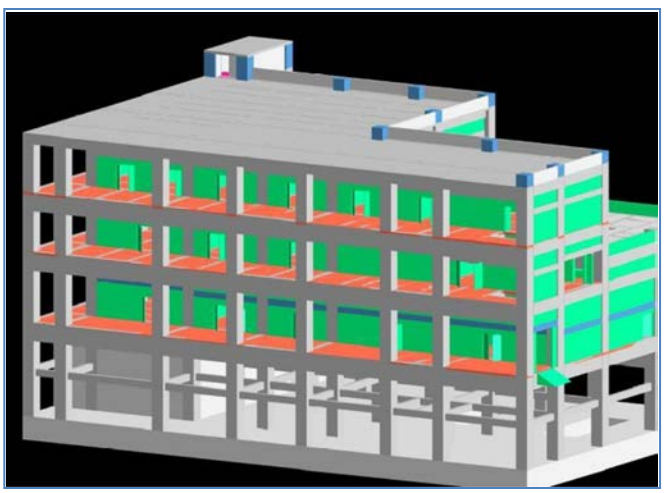

Fig 3. Typical 3-D model of a commercial/industrial building.

real time data for power flows and power quality data. We plan on making the 3D model into a Virtual Reality Modeling Language (VRML) format so that it

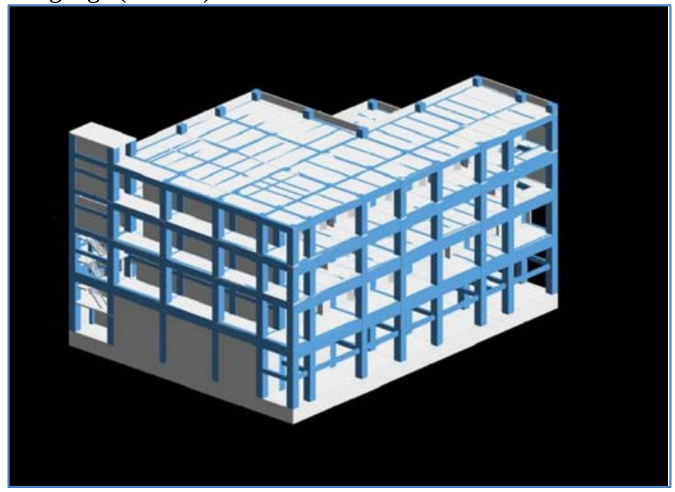

Fig. 4. Rotated view of the 3-D building model

may be displayed in any browser.

B. *Microgrid Network model*

Each microgrid will have a unique internal network model consisting of solar panels, battery, micro-source, hot water recirculation system, DC charging bus and building load centers including the HVAC load center. The entire system will be modeled using the same ISM technology used for modeling the distribution company networks, with the addition of the natural gas and the hot water circulation system. The ISM includes the coupled networks of water, gas, and electricity.

The ISM will be directly coupled with the measured loads throughout the facility. This will be done using the local PI server inside the microgrid. This server continually reads data from the measured points inside the facility. Typically this will include real time measurements of real power flow and voltage at major load centers within the facility as well as a direct connection to the HVAC energy management system. This interface is commonly through a BACnet or OPC connection which are listed in the NIST sixteen standards. Real time data from the PMUs, Solar Inverter, AC Rectifier, PCC transformer and switch as well as flows to each of the EV loads on the DC charging bus are monitored using the PI system. These loads are fed into the ISM model in real time creating a Virtual SCADA [2] system for the entire facility. The ISM continually computes the voltage, phase angle, current flows and losses at each branch in the model and continually shows these data to employees within the facility.

Simply showing users how much energy they are consuming results in an energy reduction of 10-15 percent. This is the number often quoted by Energy Commissions as the justification for installing Smart meters. Each employee will see a display of the energy consumption for the facility on their desktop computer as the log in each day. This information will also be displayed on an internal web site so will be available for employees that do not have access to a desktop computer. We expect that the energy displays will be posted in a conspicuous place such as the building lobby.

The network model computes the total losses of energy in each branch for each commodity (water, gas, electricity). The total energy loss is converted to carbon units and also displayed for all employees. This also includes a summary of the amount of stored energy in all connected storage devices including the available energy in each connected vehicle. The information computed in the ISM is available for display on the VRML model of the building and will be used to create reports automatically of the energy savings from the system.

Additionally, each facility will have a local weather station. This will measure wind speed and direction, temperature and humidity and solar intensity. This information will be used to continually create a short term forecast of the power available for dispatch to the grid. The forecast will include temperature information from the local meteorological stations including the ASOS stations. These stations report hourly data as well as and significant change in weather including ceiling height and other weather advisories. The microgrid controller will also connect to the NOAA internet site for the daily forecast of temperature and wind conditions. These data will be used by microgrid controller to generate an hour-ahead forecast of the power available to the grid. Note that this availability depends on the internal facility loads. The forecasting will be done on a five-minute interval for the next three hour period. The method used for the forecasting will be the traditional autoregressive moving average model (ARMA). Note that the model will depend on the time of day, day of week, holidays and the expected production rate of the facility.

The model will continually estimate the amount of power that would be available to the grid during period of high grid stress. This would include an estimate of the amount of load that could be shed internally. Typically this would the amount of lighting loads in peripheral offices with sufficient natural lighting (depends on time of day and solar intensity) and other energy consumption including the HVAC system. The time of dynamic response time of this energy will also be computed and included in the computation of the hour-ahead forecast of power available to the SVP grid. Based on previous tests sponsored by the CEC, the typical building HVAC response time is about 30 minutes.

The microgrid controller continually computes the energy cost to meet current load requirements. This is based on the published firm price of energy provided by the HMC. The controller determines the minimum cost to meet load and will make the decision as to whether to remain connected to the grid. This decision will be made on one minute intervals. The HMC will publish firm prices of power for the next three hours at one minute intervals. The price of energy is the LMP at the PCC of the facility. A more detailed discussion of the method of computing the LMP at the meter is outlined in following sections of this proposal. For example on a hot sunny weekend day, with high price of power due to high air conditioning loads, the microgrid may elect to shed maximum internal load, activate the micro-sources and discharge its battery so that maximum power can be sold to the HMC..

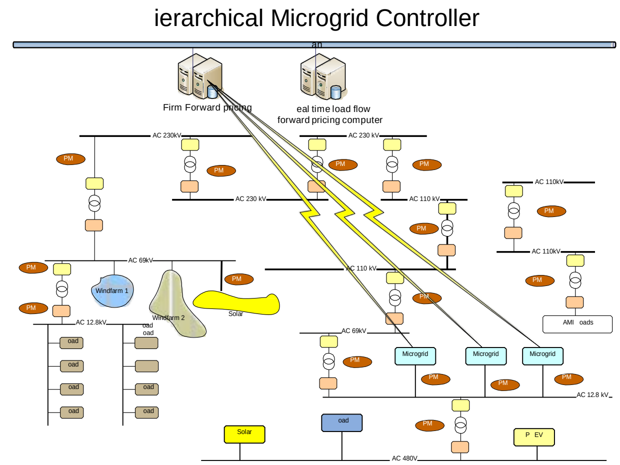

Fig. 5 Overview of a typical power aggregator with multiple microgrids.

C. *Grid operations*

The smart grid technologies will be CERTS “plug and play” within the microgrid. However, we plan on using the microcontroller to supervise and insure equipment protection both when the microgrid is connected and when operating as a separate power island. The system will also protect against “anti-islanding” when the connected grid is black. The fast switch will open when the grid becomes unstable or is in brown out or blackout conditions. Thus each microgrid will have its own “black start” capability. This will be recognized by the high side PMU that will continually be performing real time FFTs to assess small signal stability issues. This technology is described in [1].

Instabilities can arise due to the fact that there will be many micro-generators as well as the main combustion turbine inside SVP network. This will be common in “deep penetration” distributed energy resources based systems. The larger combustion turbine generator can interact with the micro generators potentially causing small signal stability issues. The ISM will detect these as well as the PMUs on the high side of each microgrid.

The proposed system will be built in standard modules. There will be one “control” module (a 2.5 by 4 meter enclosure) housing the computers and relays. A second module will house the battery. The battery module will be fabricated from standard battery modules to fit inside the same size enclosure as the main control module. The CERTs electronic devices are attached to the individual generation equipment and the frequency switches are located in the control module.

Thus the system as designed can be manufactured in high volume and can be transported to the site by normal tractor-trailer. In any event, the battery module has exactly the same look from the outside as the control module.

The carport structures are standard and can be prefabricated and delivered on site.

One innovative approach is the 3D CAD model of the parking lot and the buildings. The CAD model is used to create all fabrication drawings as well as a VRML model for real time display for power consumption at each load point. The key performance indicators (KPI) are automatically monitored by the OSIsoft PI Server located in the control module. The microgrid team will work with the DOE to define a set of KPIs for this project. The building EMS data will be used to compute standard KPI such as watts/m^2 and watts/person consumed prior to the commissioning of the solar panels. The KPI will also include carbon footprint for the facility. This will include commonly used metrics such as gram/ m^2 of building area, grams/employee and total tonnes of carbon per unit product manufactured, for example if a certain chip were manufactured in the facility, the KPI could be grams carbon/unit shipment of a component.

D. *Using PMUs*

Each microgrid will include two PMUs; located on either side of the transformer. The low side PMU will be used as the master microgrid frequency sensor and will be available to all devices on the microgrid via IEC 61850 Goose messages. Additionally the voltage will be measured using the low side PMU. This will also be available to all devices on the microgrid via Goose messages. Additionally the PMU will measure the first 50 harmonics in both current and voltage in each phase. This information will be used to assess the effect of switching power supplies inside the building and in particular the data center functions within the microgrid.

The transformer condition monitoring will be applied across the transformer. This is a software technology that continually computes the real and reactive components the impedance across each of the nine transfer paths in the transformer.

Additionally, a grid warning patent [1] will be implemented using the high side PMU frequency measurements. This approach uses real time FFTs to determine the overall health of the grid. It automatically determines the peak locations in the spectrum of frequency and then makes an assessment of whether the peaks are growing too fast. The system also computes the damping coefficient in real time with no external perturbations.

III. Hierarchical Control of microgrids

A. *Pricing models*

The Cazalet real time pricing algorithms developed as follow-on to the work done in the early 1990's by APX Corporation, a real time power exchange company founded by Cazalet.

Firm fixed prices will be computed for each meter throughout the entire city. This information will be firm fixed prices guaranteed for the next few hours. Real time settlements will be made using these firm prices. The price of power supplied to the load is computed to using the ISM model as the constraining variable and for solving the optimum load flow of the power network. The cost of delivering power is based on the cost of purchasing it, or creating it internally using natural gas, or from the microgrids. The microgrids will offer a firm price per MWh from the solar microgrids. The other power will be delivered based on long term contracts with energy suppliers and the local combustion turbines operated by the grid. The cost includes all losses in the distribution system. The price is then determined by adding the required margins to the price.

During periods of low supply the prices to the microgrids will increase. The microgrid may wish to sell more power into the grid at these high prices. This is accomplished by turning on the local generation and curtailing internal load as much as possible. One can imagine the case where the microgrid would shed all non-essential loads and offer maximum power to the grid at the offered price point. As more microgrids begin adding power, the price will come down the optimum equilibrium price.

B. *Design*

The hierarchical microgrid controller consists of the ISM model running in faster than real time to compute the forward price of power at each meter in the grid. The calculations are based on the cost of delivering power to the meter which is mainly related to the losses of power in the distribution process. This cost is a strong function of the topology of the circuit. So during each calculation the topology must be known. This information will be passed to the HMC via the "Circuit Server" software. This is the identical model used internally within the distribution for EMS operations and for interface to their GIS system. There will be a guarantee that the position of all switches in the network will be known to the HMC within the five minute interval of calculation.

The calculations will be performed using the ISM in Distributed Computing mode. The computation will be done using approximately 128 distributed computers located in a remote data center.

The HMC model will be updated at 5 minute intervals from the main circuit server model. The model transfer will be over an encrypted VPN tunnel between the distribution company and the HMC. This will meet the NERC CIP requirements.

C. *Hardware*

The solar panels costs are rapidly dropping and it is expected that the cost will stabilize around $2/kW. Battery and micro-generator costs are also dropping. The microgrid controller will be supplied by a company offering digital relay technology and the data historian will be supplied by OSIsoft. The network model calculations will be done on a series of powerful servers. The ISM inside the microgrid will be run on 4 to 8 computers and the ISM for the grid network will require 128 powerful servers.

The real time optimum pricing policy can be found by solving a dynamic programming problem with constraints on generation, transmission, and distribution.

The performance function is the gross profit for generators, transmission operators, and loads. Traders, industrial and commercial users, and the spendable income of residential customers (net income-power bill) could also be included. This approach supports modulating price responsive loads.

The condition for local optimality will be when the derivatives of performance function with respect to generation and load (commonly called λ, the Lagrangian multiplier) are equal. At each five minute interval, the generalized economic dispatch problem is solved. The problem may be formulated mathematically as follows:

$$J = \max_{P_G, P_L} \left\{ \sum_{i=1}^{G} \left(I_i(P_{Gi}) - C(P_{Gi}) \right) - \sum_{j=1}^{L} \left(I_j(P_{Lj}) - C(P_{Lj}) \right) \right\}$$

where I_i represents income, C represents cost, nG is the number of generators, L_j is the number of loads, P is power, and J is the performance function. A necessary condition for optimality is when the total derivative of J is zero and the partial derivatives of J with respect to P are equal. In this case the generation cost functions are known. This includes both fixed and operating cost for each generator. The income terms for the generators are to be determined by the optimization problem. In optimal control problems these terms are normally defined as controls and are often represented by the symbol "u". For the loads, the C term is the cost of power to the consumer. This would be the price charged for each type of contract and for each class of load. The I term for the loads is the value of goods and services provided by the loads. In the case of residential loads, it is the salary of the worker. The problem is to find the I function for the generators and the C function for the loads that maximizes J.

The pricing policy over a four to five hour period will be determined by the demand shedding contracts for each load and generator class (there will be must serve constraints for both the loads and the generation in the problem formulation) This problem will be solved using dynamic programming methods. For each time interval, the price is determined so that the expected performance is maximized over the remaining time intervals. The solution mechanism is highly computer intensive; however, with today's computers these problems may be solved fast enough for real time decisions.

The resulting price elasticity model would be published so that each consumer would be able to individually maximize their respective comfort index.

The ISM from EDD will be the model used to determine the electrical constraints on the real time pricing. The actual pricing algorithms will supplied by Cazalet group. The theoretical basis for this approach is outlined in text by Prof. M. Ilic, in her book, "Hierarchical Power Systems Control.[3]"

Real time data from system will be available to authorized public interested in learning the performance of the microgrids and Hierarchical systems. It is expected that at least 1000 simultaneous connections will be supported. The portal software will also run in "the cloud."

Microgrids will be controlled by issuing a dynamic forward price for energy to each microgrid. The pricing will be computed using the Cazalet algorithm. The ISM model is to minimize energy losses in the distribution network and to assure that distributed generation resources can be connected to the grid. As an example, the model Silicon Valley Power was originally developed using the ISM from EDD. The network model is shown in Fig. 6. This is a three-phase model for the electricity network and a compressible

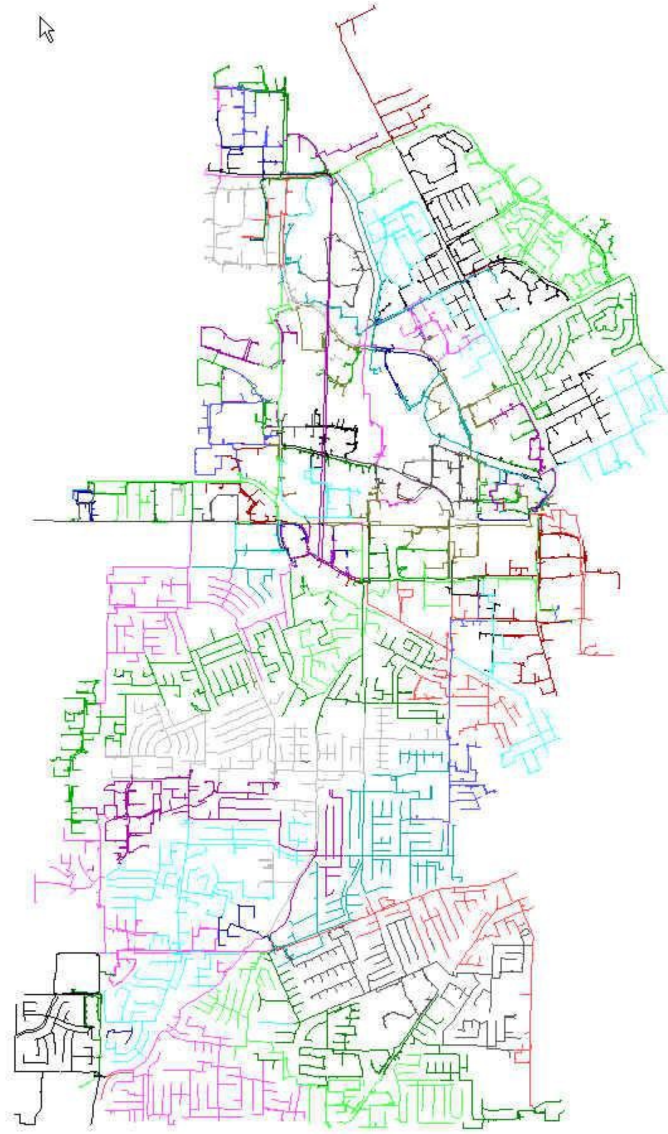

Fig. 6 The network model of a typical municipal utility

gas network for the natural gas section of the model. The modeling will also handle water and sewage networks as well since these are also part of the infrastructure network. The models are then used in real time for control as well as planning for additional renewable power sources.

A power aggregation project was completed several years ago by EDD for the Detroit Edison Company. This project included aggregating and bidding DER power from distributed resources into the local market. The project was co-funded by the US DOE.

The model will run in real time. This means solving a three-phase load flow many times in a period of less than one second. This will require a number of loosely coupled distributed computers. We will use a single rack of one-hundred twenty eight high-end blade servers for direct control of the microgrids. The number of servers could increase significantly to allow the optimum pricing controls to be computed nearly in real time. Some of the information used by the model will include the real-time frequency and voltage measurements made at each microgrid interface as well as the absolute phase angle directly (this is an innovative use of the PMU data since most uses thus far use relative angles). These are made with PMU devices. The PMU data could be forwarded to NASPInet.

This project will be one of the first fully integrated solar microgrid projects in the USA. The system will also be the first to implement solid-state transformer technology. Figures and Tables

IV. Acknowledgment

The author gratefully acknowledges the contributions of Prof. Robert H. Lasseter, Univ. Wisconsin and Prof. Robert Broadwater, Virginia Polytechnic Institute for their work on the original concepts outlined in this paper and to Dr. Ed Cazalet for introducing fixed forward pricing controls for the microgrids. And for the contributions of Albert Saenz of Silicon Valley power for guidance on how microgrids will fit into the Silicon Valley Power network.

V. References

[1] C.H. Wells, "Power Grid failure detection system and method," U.S. Patent 7,498,821 February 10, 2009.

[2] C.H. Wells, "Nonlinear observers in electric power networks," US Patent 7,498,821, March 3, 2009.

[3] M.Ilic and Liu, *Hierarchical Power Systems Control*.. New York: :Its Value in a Changing Industry, Springer-Verlag, London Limited, 1966.

VI. Biographies

Charles H. Wells was born in Kokomo, Indiana. . He graduated from Vanderbilt University with a BS degree in Chemical Engineer and from Washington University with a MS in Chemical Engineering and a D.SC in Electrical Engineering. He is a registered Professional Engineer in both Chemical Engineering and Control Engineering in the state of California.

His employment experience included Systems Control, Measurex, EPRI and OSIsoft His special fields of interest includes control systems.

Wells published over 60 technical papers and is co-author of two textbooks. He has been granted seven patents.

ATTACHMENT 10
Contact List

California Energy Commission	Recipient
Commission Agreement Manager: (TBD) California Energy Commission 1516 Ninth Street, MS-51 Sacramento, CA 95814 Phone: (916) 327-XXXX Fax: (916) 327-XXXX e-mail:	**Project Manager:** Alfredo Martinez-Morales Managing Director, Research Faculty So Cal Research Initiative for Solar Energy University of California- Riverside 1084 Columbia Ave Riverside, CA 92507 Phone: (951)781-5652 Fax: (951) 781-5790 e-mail: alfmart@ece.ucr.edu
Commission Agreement Officer: (TBD) California Energy Commission 1516 Ninth Street, MS-1 Sacramento, CA 95814 Phone: (916) 654-XXXX Fax: (916) 654-XXXX e-mail:	**Administrator:** Ursula Prins Principal Contract & Grant Officer University of California – Riverside 200 University Office Bldg Riverside, CA 92507 Phone: (951) 827-4808 Fax: (951) 827-4483 e-mail: ursula.prins@ucr.edu
Accounting Officer: (TBD) California Energy Commission 1516 Ninth Street, MS-2 Sacramento, CA 95814 Phone: (916) 654-XXXX Fax: (916) 654-XXXX e-mail:	**Accounting Officer:** Mr. Fred Devera Extramural Funds Administrator Accounting Office-002 Riverside, CA 92521 Phone: (951) 827-3303 Fax: (951 827-3314 e-mail:fred.devera@ucr.edu
Legal Notices: Tatyana Yakshina Grants and Manager 1516 9th Street, MS-1 Sacramento, CA 95814 Phone: (916) 654-4204 Fax: (916) 654-4076 e-mail: tatyana.yakshina@energy.ca.gov	**Legal Notices:** Ursula Prins Principal Contract & Grant Officer University of California – Riverside 200 University Office Bldg Riverside, CA 92507 Phone: (951) 827-4808 Fax: (951) 827-4483 e-mail: ursula.prins@ucr.edu

ATTACHMENT 11
Commitment and Support Letters

Letter of Commitment/Support # 1 of 7 for UC Riverside	
Type of Letter	☒ Commitment ☐ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☐ Project Partner ☐ Pilot Test/Demonstration/ Deployment Site
Type of Match Funding *(if applicable)*	☐ Cash in hand ☐ Equipment ☐ Materials ☐ Information technology services ☐ Travel ☐ Subcontractor costs ☐ Contractor/project partner in-kind labor Costs ☒ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Mark R. Matsumoto, Associate Dean, Research and Graduate Affairs
Phone Number and Email Address of Author	Phone: 951-827-5190 Email: matsumot@engr.ucr.edu
Address of Author (city, state, and zip code)	Office of the Dean, 446 Winston Chung Hall, Riverside, CA 92521-0144

Bourns College of Engineering
Office of the Dean
446 Winston Chung Hall
Riverside, CA 92521-0144
(951) 827-5190

January 14, 2015

California Energy Commission
1516 Ninth Street, MS-18
Sacramento, California 95814

Re: Letter of Commitment, PON-14-307, Demonstration of community scale low cost highly efficient PV and energy management system at the Chemehuevi Community Center (CCC)

The University of California, Riverside (UCR) is the lead organization for this proposed project and one of several contributors to the cost sharing. UCR's commitment to this project will consist of salary, benefits, and applicable overhead for key personnel. Ladder faculty members are expected to devote a portion of their academic year time and effort, while being paid by the University, to research. We commit to at least the following University-paid effort toward this project:

Professor Matthew J. Barth, a Co-Principal Investigator in this project, holds a full-time faculty appointment in the Department of Electrical and Computer Engineering, and is Director of the College of Engineering-Center for Environmental Research and Technology (CE-CERT). He will devote at least 3% of his academic year time and effort from 2015-16 to 2017-18 to this project.

Professor Nanpeng Yu, a Co-Principal Investigator in this project, holds a full-time faculty appointment in the Department of Electrical and Computer Engineering. He will devote at least 5% of his academic year time and effort from 2015-16 to 2017-18 to this project.

Additionally, Dr. Sadrul Ula is Managing Director of the Winston Chung Global Energy Center. He is paid from University endowment funds for this role. He will devote a total of 2.0 months of effort to this project in years 1-3 and 1.0 month in year 4 (the final month) of the project. We will costshare 10% of this effort.

Collectively, we calculate that these commitments amount to $42,556 in salary, plus $8,736 in applicable fringe benefits. Additionally, as per federal accounting guidelines, applicable facilities and administrative costs totaling $13,336 for facilities charges and $12,823 in indirect costs. The combined total of UCR's commitment, therefore, is $77,451 between July 2015 and July 2018.

We consider the statements made above to be binding, unconditional commitments to the project. If changes in personnel result in the removal of any key personnel from the project, a qualified substitute will be found, or the remaining principals will increase their effort. This will assure that we will fulfill our commitment in its entirety.

Sincerely,

Mark Matsumoto

Mark R. Matsumoto
Associate Dean, Research and Graduate Affairs
Bourns College of Engineering

ATTACHMENT 11
Commitment and Support Letters

Letter of Commitment/Support # 2 of 7 for UC Riverside		
Type of Letter	☒ Commitment	☐ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☐ Pilot Test/Demonstration/ Deployment Site	☒ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☒ Equipment ☒ Materials ☐ Information technology services ☒ Travel	☒ Subcontractor costs ☒ Contractor/project partner in-kind labor Costs ☐ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Dr. Gilad Almogy, CEO & Founder	
Phone Number and Email Address of Author	(650) 230 3434 Gilad.almogy@cogenra.com	
Address of Author (city, state, and zip code)	Cogenra Solar 46453 Landing Parkway, Fremont, CA 94538	

COGENRA SOLAR

January 15, 2015

Gilad Almogy
Cogenra Solar Inc.
46453 Landing Parkway
Fremont, CA 94538

To

Dr. Alfredo Martinez-Morales
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507

Subject: In support of UC Riverside's response to California Energy Commission Program Opportunity Notice 14-307 entitled "Demonstrating Clean Energy Solutions That Support California's Industries, the Environment, and the Electrical Grid"

Dear Dr. Alfredo Martinez-Morales & California Energy Commissioner,

This proposed project titled "*Demonstration of community scale low cost highly efficient PV and energy management at the Chemehuevi Community Center*", has great promise for demonstrating viable pre-commercial technologies in energy generation, energy storage, and advanced strategies peak shaving, load shifting and demand response. Cogenra Solar will serve as a partner in this project and hereby makes the following commitments toward it:

1. Project site. The project team will provide our innovative, Slate™ modules, , to carry out the demonstration project at the Chemehuevi Community Center located at 1978 Valley Mesa Rd. Havasu Lake, CA 92363
   - Cogenra's latest innovative PV modules, called Slate™, are in the form-factor of a conventional 60-cell PV panel incorporating its break-through Dense Cell Interconnect (DCI) technology. The DCI technology, originally developed to maximize the performance, output and reliability of the Cogenra T14 LCPV system, has recently been incorporated into flat plate PV panels and achieved third-party verified world record module power, significantly better intrinsic reliability and brilliant perfect black aesthetics. While utilizing existing PV cells, the DCI technology enables elimination of bus-ribbons, solder-joints on PV cells and inter-cell gaps. In late-October, Cogenra announced three world record setting modules and the manufacturing of these in California. The up-to-15% boost to module power and efficiency presented by Slate will enable higher kW per roof, lower overall BOS costs, generate more profits per roof and

hence drive solar adoption. The Slate™ modules are 3rd party tested and have completed all the requirements for IEC certification but are pre-commercial and yet to be installed in any commercial setting.

2. For this EPIC project, Cogenra would provide Slate™ panels amounting to a total capacity of 50kW at a cost of $99,000 to UC Riverside. The funding received from UCR through the CEC grant, totaling $99,000 for Cogenra's Slate™ technology, will be devoted towards the development and testing of Cogenra's innovative and pre-commercial PV modules.

3. Cogenra is further able to support the project efforts with an in-kind matched funding of $25,000. The contributions on behalf of Cogenra are existing, institutional internal development resources not subject to contingency conditions.

All of these expenditures will take place in California. We consider the statements made above to be binding, unconditional commitments to the project. Because our commitments are directly linked to the installation and operation of the subject technology, we consider the risk of failure to fulfill these obligations to be minimal.

All of these commitments have been duly authorized by our executive team, and I am authorized to sign this binding letter. We look forward to your support for this exciting project. The pre-commercial value for Cogenra's Slate™ technology, and related services being provided by Cogenra is $124,000; the in-kind contribution (cost sharing) from Cogenra is $25,000.

This is a very critical and vital project for Cogenra and the entire Cogenra team will support the project for a successful completion. The match funds are a combination of equipment, material, travel and sub-contractor in-kind labor costs. The match funding will be sourced from capital contributed by private investors. Cogenra's primary investor is Khosla Ventures. Today Khosla Ventures has one of the largest and broadest clean technology portfolios (including solar, energy storage, nuclear power, wind and high-efficiency engines), as well as holdings in traditional technology sectors such as mobility, Internet and silicon. Khosla Ventures has supported Cogenra since the company's inception in 2009.

Sincerely,

Dr. Gilad Almogy
CEO, Cogenra Solar Inc.

ATTACHMENT 11
Commitment and Support Letters

Letter of Commitment/Support # 3 of 7 for UC Riverside		
Type of Letter	☒ Commitment	☐ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☐ Pilot Test/Demonstration/ Deployment Site	☒ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☒ Equipment ☒ Materials ☐ Information technology services ☒ Travel	☒ Subcontractor costs ☒ Contractor/project partner in-kind labor Costs ☐ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Andrew Marshall, Director of Utility Solutions	
Phone Number and Email Address of Author	510-342-7647 Andrew.Marshall@primuspower.com	
Address of Author (city, state, and zip code)	Primus Power 3967 Trust Way, Hayward, CA 94545	

January 14, 2015

California Energy Commission
1516 Ninth Street, MS-18
Sacramento, California 95814

Re: In support of UC Riverside's response to California Energy Commission Program Opportunity Notice 14-307 entitled "Demonstrating Clean Energy Solutions That Support California's Industries, the Environment, and the Electrical Grid"

Primus Power, an energy storage manufacturer based in Hayward, California, is delighted to offer our support and technology to the UC Riverside EPIC 14-307 project. We believe this microgrid will provide immediate benefit for California ratepayers through the demonstration of viable, pre-commercial technologies in energy generation, energy storage, advanced peak shaving strategies, load shifting and market-based demand response. Primus will serve as a Partner in this project and hereby makes the following commitments toward it:

1. Primus will provide a 30kW EnergyCell, employing our unique and patented zinc-bromine flow battery design, to carry out the demonstration project. We will facilitate the installation of our product.

2. Time and effort. We calculate that personnel time and effort involved in the installation, acceptance, and operation at this location will total $120,780 over the 37-month duration of the project. These costs include direct labor and applicable benefits/overhead. All of these expenditures will take place in California.

Primus will contribute a matching funds totaling $21,780. The contributions on behalf of Primus are existing, institutional internal development resources not subject to contingency conditions. Separate funding received from UCR through the CEC grant, totaling $99,000 for our technology will be devoted to the development, testing and operation of the EnergyCell.

We consider the statements made above to be binding, unconditional commitments to the project. Because our commitments are directly linked to the installation and operation of the subject technology, we consider the risk of failure to fulfill these obligations to be zero. If, for any reason, our actual commitments are on track to be less than what is committed here, we will make appropriate arrangements with the University of California, Riverside, to replace the lost value to the project.

I am authorized to sign this binding letter. We look forward to your support for this exciting project.

Sincerely,

Andrew Marshall
Director of Utility Solutions

Letter of Commitment/Support # 4 of 7 for UC Riverside		
Type of Letter	☒ Commitment	☐ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☐ Pilot Test/Demonstration/ Deployment Site	☒ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☐ Equipment ☐ Materials ☒ Information technology services ☐ Travel	☐ Subcontractor costs ☐ Contractor/project partner in-kind labor Costs ☒ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Martin Otterson, Sr. VP. Sales and Marketing	
Phone Number and Email Address of Author	Phone: 510-297-5800 Email: sales@osisoft.com	
Address of Author (city, state, and zip code)	777 Davis Street, San Leandro, CA 94577	

January 14, 2014

Subject: Letter of Commitment – CEC PON 14-307 Group 2 Clean Energy Solutions Demonstration Projects – Demonstration of community scale low cost highly efficient PV and energy management system at the Chemehuevi Community Center (CCC).

Cory Irish, PON-14-307
Contracts, Grants, and Loans Office, MS-18, California Energy Commission
1516 Ninth Street, 1st Floor, Sacramento, CA 95814

Dear Sir:

OSIsoft LLC is pleased to offer this Letter of Commitment to the University of California, Riverside ("UCR") in response to its proposal to CEC PON-14-307, "Demonstrating Clean Energy Solutions That Support the California's Industries, the Environment, and the Electrical Grid" for the proposed project called **Chemehuevi Community Project,** hereafter referred to as the Project, which will deploy and demonstrate a 50 kW mid-concentration solar PV system, a 40 kW high-performance solar PV system, and a 60 kWh/30 kW flow-battery energy storage system (FBESS) to integrate and manage: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities at the demonstration community.

OSIsoft has been supporting research, academic pursuits and innovation with the University of California for many years. We are particularly pleased to support the goals of this CEC PON 14-307 proposal which will be sited at the Chemehuevi Community Center (CCC), the designated Emergency Response Center for the Chemehuevi Indian Tribe. Having fail-safe power supply for emergency response centers is a major state-wide and global concern.

The integration and deployment of two pre-commercial solar PV technologies permits optimum flexibility in energy management while demonstrating the unique characteristics of each technology, and their advancement, compared to standard commercially available products.

To optimize the economic savings made possible by the proposed power generation, storage, and energy management system, the project will be working with the Chemehuevi Indian Tribe and Southern California Edison to perform operation and demonstration of a system incorporating solar and load forecasting, facility energy demands, and utility demand response, while collecting real-time system data using the OSIsoft PI System; implementing interoperability, control and communication protocols that can be replicated at scale. The project will be validating system operation, quantify electrical demand impacts, and quantify emission offsets.

We are further in support of the project developing use case(s) and the development of user-friendly guides to appropriately size systems to meet the needs of similar communities.

OSIsoft, LLC is a privately held software company based in California. The proposed software is developed and made in California. The PI System is used extensively throughout the power industry, by power generation (fossil fuel, nuclear and renewables) as well as by many Transmission & Distribution companies. The system is used by all ISOs, and IOUs, including PG&E, SDG&E, CAISO, PeakRC and many other organizations throughout California, North America and globally. The PI System is also used heavily in the process industries with customers in pharmaceutical, chemical, beverage and other sectors. The PI System is reliable, commercial software that is used by companies on 'both sides of the power meter". OSIsoft is excited to support this clean energy solution demonstration that will benefit our industrial customers and power customers as well as CA ratepayers.

OSIsoft, LLC will participate in this project by providing PI System software to UCR for a total software license fee of $50,000. The proposed PI System includes a PI Server data archive and asset repository, real-time data gathering methods (Interfaces or PI Cloud Connect), PI Analytics, and use of our standard visualization clients. OSIsoft will also provide up to six weeks of system installation and training services during project implementation, and will provide 24/7 technical support and software updates for the 3 year project. The commercial value of the software, and related services being provided by OSIsoft is $529, 467; the **in-kind contribution (cost sharing) from OSIsoft is $479,467**.

This PI System software will enable you to meet the requirement to collect and store at least 12 months of data. The PI System will also simplify the task of documenting, and improving, operational performance.

In addition, certain intellectual property owned by OSIsoft, LLC can be used in your CEC PON 14-307 demonstration project if needed. The relevant US patents are:
8,498,752--- Decoupling controller for power systems
8,457,912--- Unwrapping angles from phaser measurement units
7,961,112--- Continuous condition monitoring of transformers 7,755,371-
-- Impedance measurement of a power line
7,498,821--- Non-linear observers in electric power networks 7,490,013-
-- Power grid failure detection system and method

OSIsoft, LLC offers to non-exclusively license this patented technology to UCR at no cost for the CEC PON 14-307 EPIC Program. OSIsoft will offer UCR, as an awardee of CEC PON 14-307 grant, a perpetual use license to our software, under our standard terms and conditions, specifically for demonstration purposes only for the duration of the grant. For any commercial use of the software, we would seek a mutually agreed commercial license. We consider the statements made above to be binding, unconditional commitments to the project. If, for any reason, our actual commitments are on track to be less than what is committed here, we will make appropriate arrangements with the University of California, Riverside, to replace the lost value to the project.

I am authorized to sign this binding letter. We are looking forward to working with UC Riverside and other team partner o this innovative technology demonstration project

Sincerely,

Martin Otter r. VP. Sa es and Marketing

Cc OSIsoft legal

www.osisoft.com 777 Davis Street I San Leandro CA 94577 USA I (510) 297-5800

ATTACHMENT 11
Commitment and Support Letters

Letter of Commitment/Support # 5 of 7 for UC Riverside		
Type of Letter	☒ Commitment	☐ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☐ Pilot Test/Demonstration/ Deployment Site	☒ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☐ Equipment ☐ Materials ☐ Information technology services ☐ Travel	☐ Subcontractor costs ☐ Contractor/project partner in-kind labor Costs ☒ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Mark Kerstens, Chief Sales & Marketting Officer, Acting CEO	
Phone Number and Email Address of Author	Phone: 408-240-3800 Email: mark.kerstens@solexel.com	
Address of Author (city, state, and zip code)	1530 McCarthy Blvd., Milpitas, CA 95035	

SOLEXEL

California Energy Commission
1516 Ninth Street, 1st Floor
Sacramento, California 95814

January 16, 2015

SUBJECT: In support of UC Riverside's response to California Energy Commission Program Opportunity Notice 14-307 entitled "Demonstrating Clean Energy Solutions That Support California's Industries, the Environment, and the Electrical Grid"

This proposed project has great promise for demonstrating viable pre-commercial technologies in energy generation, energy storage, and advanced strategies peak shaving, load shifting and demand response. Solexel, Inc. will serve as a Partner in this project and hereby makes the following commitments toward it:

1. Project site. The project team will provide our Solexel solar modules to carry out the demonstration project. We will facilitate the installation of our solar module.

2. Time and effort. We calculate that personnel time and effort involved in the installation, acceptance, and operation/analysis of at this location will total $12,000 over the 37-month duration of the project. These costs include direct labor and applicable benefits/overhead. All of these expenditures will take place in California.

Solexel, Inc. will contribute a match share totaling $12,000. The contributions on behalf of Solexel are existing, institutional internal development resources not subject to contingency conditions. Separate funding received from UCR through the CEC grant, totaling $80,000 for Solexel solar modules, will be devoted towards the construction and supply of innovative solar modules.

We consider the statements made above to be binding, unconditional commitments to the project. Because our commitments are directly linked to the installation and operation of the subject technology, we consider the risk of failure to fulfill these obligations to be zero. If, for any reason, our actual commitments are on track to be less than what is committed here, we will make appropriate arrangements with the University of California, Riverside, to replace the lost value to the project.

All of these commitments have been duly authorized by our management, and I am authorized to sign this binding letter. We look forward to your support for this exciting project.

Sincerely,

Mark Kerstens, Chief Sales & Marketing Officer, Acting CFO

Solexel, Inc.
Tel: (408) 240-3800 / Fax: (408) 240-3897 / 1530 McCarthy Blvd. Milpitas, CA 95035-7405

Letter of Commitment/Support # 6 of 7 for UC Riverside		
Type of Letter	☐ Commitment	☒ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☐ Match Funding ☐ Pilot Test/Demonstration/ Deployment Site	☐ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☐ Equipment ☐ Materials ☐ Information technology services ☐ Travel	☐ Subcontractor costs ☐ Contractor/project partner in-kind labor Costs ☐ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Robert Sherick, Principal Manager	
Phone Number and Email Address of Author	Phone: 714 934-0813 Email: Robert.Sherick@sce.com	
Address of Author (city, state, and zip code)	2244 Walnut Grove Avenue, Quad 1a, Rosemead, CA 91770	

SOUTHERN CALIFORNIA
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January 15, 2015

Alfredo A. Martinez-Morales, Ph.D.
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507

Subject: Letter of Support for University of California Riverside's proposal for Funding Opportunity: CEC-PON-307.

Dear Sirs:

Southern California Edison is pleased to offer this support letter to the University of California, Riverside (UCR) in its application to the California Energy Commission's (CEC) Program Opportunity: CEC-PON-307, "Demonstrating Clean Energy Solutions that Support California's Industries, the Environment, and the Electrical Grid". SCE continues to support clean energy solutions and has done extensive studies, large scale demonstration projects, and ongoing integration of clean energy resources throughout our service area. This current CEC funding opportunity will be very beneficial to continuing the evolution of the electric grid.

SCE supports the objective of demonstrating and deploying community scale generators and innovative energy management strategies. SCE is currently conducting the Irvine Smart Grid Demonstration (ISGD) program, soliciting clean energy resources for the Preferred Resources Pilot (PRP), and developing a detailed design for an Integrated Grid Project (IGP) demonstration to enable and optimize clean energy solutions. SCE believes the proposed work by UCR and their partners could benefit from sharing lessons learned from these efforts.

SCE, a subsidiary of Edison International (EIX), is an investor-owned electric utility operating in the state of California, covering over 50,000 square miles and serving 14 million people.

SCE's participation in this project is as a technical advisor to the Project. This contribution will be in the form of SCE performing certain advisory work for the Project, with the scope of these activities to be mutually acceptable to SCE and UCR. Because SCE will not be seeking reimbursement, SCE expects to be able to provide this type of support for the Project without being subject to the terms and conditions that may apply to a subrecipient or vendor for the Project.

Yours truly,

Robert Sherick

Robert Sherick
Principal Manager
Southern California Edison

Letter of Commitment/Support # 7 of 7 for UC Riverside		
Type of Letter	☒ Commitment	☒ Support
Commitment Letter Subject Matter *(select one or more as appropriate)*	☒ Match Funding ☒ Pilot Test/Demonstration/ Deployment Site	☒ Project Partner
Type of Match Funding *(if applicable)*	☐ Cash in hand ☐ Equipment ☐ Materials ☐ Information technology services ☐ Travel	☐ Subcontractor costs ☐ Contractor/project partner in-kind labor Costs ☒ Partner in-kind labor Costs ☐ Advanced practice costs
Author of Letter (name and title)	Glenn Lodge, Vice Chairman Chemehuevi Indian Tribe	
Phone Number and Email Address of Author	Phone: 760-858-1116 Email: citvicechair@gmail.com	
Address of Author (city, state, and zip code)	1980 Palo Verde Dr., Needles, CA 92363	

Chemehuevi Indian Tribe

P. O. Box 1976 · Havasu Lake, CA 92363 · (760) 858-4219 · Fax: (760) 858-5400

January 12, 2015

California Energy Commission
1516 Ninth Street, MS-18
Sacramento, California 95814

Letter of Commitment from the Chemehuevi Indian Tribe

Re: PON-14-307 *Demonstrating Clean Energy Solutions That Support California's Industries, the Environment, and the Electrical Grid, proposed by University of California, Riverside*

This proposed project has great promise for reducing our reliance on the current IOU electrical grid. The project will also contribute to the goals of California AB 32 causing a further reduction in peak energy demands. The Chemehuevi Indian Tribe will serve as a Partner in this project and hereby makes the following commitments toward it:

1. Project site. The project team will be provided access to our facility at our Tribal Community/Emergency Relocation Center located at 1978 Valley Mesa Road, Havasu lake, California to carry out the demonstration project. We will facilitate the installation of the two pre-commercial solar technologies, the flow battery system and the implementation of the advanced Energy Management strategies at this location.

2. Time and effort. We calculate that personnel time and effort involved in the installation, acceptance, and operation/analysis of the EMS and SCADA at this location will total $91,000 over the 37 month duration of the project. These costs include direct labor and applicable benefits/overhead. All of these expenditures will take place in California.

We consider the statements made above to be binding, unconditional commitments to the project. Because our commitments are directly linked to the installation and operation of the subject technology, we consider the risk of failure to fulfill these obligations to be zero. If, for any reason, our actual commitments are on track to be less than what is committed here, we will make appropriate arrangements with the University of California, Riverside, to replace the lost value to the project.

All of these commitments have been duly authorized by our Tribal Executive Committee, and I am authorized to sign this binding letter. We look forward to your support for this exciting project.

Chemehuevi Indian Tribe

P. O. Box 1976 • HAVASU LAKE, CA 92363 • (760) 858-4219 • FAX: (760) 858-5400

Sincerely,

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Vice Chairman
Chemehuevi Indian Tribe

APPENDIX D:

AUGUST 12th E-MAIL BETWEEN ALFREDO MARTINEZ-MORALES AND HASSAN MOHAMMED

From: Alfredo Martinez-Morales [mailto:alfmart@ece.ucr.edu]
Sent: Wednesday, August 12, 2015 4:03 PM
To: Mohammed, Hassan@Energy
Cc: Sadrul Ula; Mike Todd; Glenn Lodge; Steve Ramirez
Subject: Re: Grant Agreement EPC-15-003 with UC Riverside - Review of Tribe's Environmental Assessment

Hassan,

Here are some short answers to the additional questions:
1) What are the number and frequency of truck deliveries expected during construction and operation?
During construction there will be approximately eight truck deliveries, within a 2-week period, for delivering the solar PV system components (modules, inverters, BOS), the carport structure, and the battery system components (flow battery, inverter). During operation, no truck deliveries are expected.
2) During operation, how often would the PV panels is washed? Approximately how many gallons of water would be used for washing? Please identify the source of this water.
The solar modules will be washed as needed, based on a reduction in generation of more than 10%. It is anticipated that the solar panels will be washed about three times a year.
For the proposed 90 kW PV system, it is estimated that 180 gallons of water would be needed per washing event.

The water being used will be from the public water system (PWS). The source of water is a ground water aquifer located near the Airport on the Chemehuevi Tribal Land.

Many thanks,

Alfredo

--
Alfredo A. Martinez-Morales, Ph.D.
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507
Tel. (951) 781-5652; Fax (951) 781-5790

From: Alfredo Martinez-Morales
Sent: Tuesday, August 11, 2015 11:43 AM
To: Glenn Lodge; Steven Escobar
Cc: Sadrul Ula; Mike Todd; Mohammed, Hassan@Energy
Subject: FW: Grant Agreement EPC-15-003 with UC Riverside - Review of Tribe's Environmental Assessment

Dear Glenn,

Could you please take a look at the additional questions from CEC? We will call your office later today to discuss.

Regards,

Alfredo

--

Alfredo A. Martinez-Morales, Ph.D.
Managing Director, Research Faculty
Southern California-Research Initiative for Solar Energy
University of California, Riverside
1084 Columbia Avenue
Riverside, CA 92507
Tel. (951) 781-5652; Fax (951) 781-5790

From: Mohammed, Hassan@Energy <Hassan.Mohammed@energy.ca.gov>
Sent: Monday, August 10, 2015 2:59 PM
To: Alfredo Martinez-Morales
Cc: Mike Todd
Subject: FW: Grant Agreement EPC-15-003 with UC Riverside - Review of Tribe's Environmental Assessment

Hi Alfredo,
Please help us with some answers to the questions below:
1) What are the number and frequency of truck deliveries expected during construction and operation?
2) During operation, how often would the PV panels is washed? Approximately how many gallons of water would be used for washing? Please identify the source of this water.

Thanks,
Best regards,
Hassan